TABLE I. Decay times of fluors.

Fluor	Uv decay	Gamma-decay
anthracene	1.7×10^{-8} sec.	3.0×10^{-8} sec.
anthracene (−195°C)	0.8	1.3
carbazole	0.7	1.3
chrysene	2.2	2.6
diphenyl acetylene	0.25	0.4
1,4 diphenyl butadiene	0.2	0.6
fluoranthene	4.6	...
fluorene	0.88	...
perylene	1.2	...
phenanthrene	0.52	...
quaterphenyl	0.38	0.7
stilbene	0.31	0.8
terphenyl	1.1	0.6
½% anthracene in benzene	0.20 ± 0.05	...
½% terphenyl in toluene	0.25 ± 0.05	0.2

is the phase shift and f is the modulating frequency. Measurements of phase shift can be made which correspond to time decays of the order of 2×10^{-10} sec., the principal source of error for these measurements being amplifier noise. The ultraviolet source was a 10 kw carbon arc with transmission filters to limit the spectral range from 2500A to 3500A. Table I shows the results of measurements made at room temperature on some fluors together with measurements obtained by means of a pulse technique under gamma-ray bombardment.[2]

The times measured by the pulse technique have been corrected for the decay introduced by the photo-multiplier, estimated at 4×10^{-9} sec. from measurements on dark noise pulses. The accuracy of both sets of measurements was estimated to be about 10 percent. Measurements by the shorted-line technique are in substantial agreement with those of recent investigators.[3-5]

Measurements using modulated ultraviolet light were checked with measurements made by Gaviola,[6] corrected according to Tumerman.[1] For a solution of rhodamine B in water and glycerine, values of 2.5×10^{-9} sec. and 5.2×10^{-9} sec., respectively, were obtained, in agreement within experimental error with Gaviola's results. A grid-controlled x-ray tube operated at 80 kv was modulated at 10 Mc/sec. and used in place of a light source. Measurements on the decay times for stilbene, anthracene, terphenyl, diphenyl acetylene, and a ½ percent solution of terphenyl in toluene yielded results in good agreement with the ultraviolet excitation decay times. Oscillator strengths based on measurements of absorption spectra for stilbene and 1,4-diphenyl butadiene[7] were calculated as 3.5×10^{-9} sec. and 3.3×10^{-9} sec., respectively, indicating a reasonable if not fortuitous agreement with measurements on ultraviolet decays.

The discrepancies between ultraviolet and gamma-ray excitation cannot be easily resolved. A measurement on a crystal of 0.05 percent anthracene in napthalene at the anthracene wavelengths gave a mean lifetime in good agreement with the ultraviolet measurements on pure anthracene, indicating that the migration of energy within the crystal does not contribute appreciably to the measured decay time. The temperature dependence of the anthracene fluorescence was again demonstrated under ultraviolet excitation. Of equal interest were the results on a liquid solution of anthracene in benzene which gave a decay time of $2\pm0.5\times10^{-9}$ sec., and measurements on terphenyl in toluene which were in agreement with gamma-ray measurements. The measurements under x-ray bombardment were undertaken to obtain correlation with gamma-ray measurements, the agreement with ultraviolet excitation being unexpected.

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The Thermal Neutron Absorption Cross Section of Silicon*

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THE thermal neutron absorption cross section of silicon has been determined experimentally by the method of Frisch, von Halban, and Koch.[1] A Ra-α-Be neutron source was placed in a mixture of pure silica sand and water, large enough to be effectively infinite; and the thermal neutron distribution was measured with indium foils. Counting was done with mica window Geiger-Mueller counters. Correction for the indium resonance was made by determining the activation of the foils when shielded by 0.10 cm of Cd. To correct for the absorption of indium resonance neutrons by Cd, this measured activity was multiplied by the factor 1.13, determined for indium foils of the thickness used (58 mg/cm²). Sufficient data were taken to make the space integrals of the thermal neutron density good to 2 percent in the case of the sand-water mixture, 2 percent in one experiment in which the comparison mixture was a heterogeneous lattice consisting of graphite rods and water, and 1 percent in another experiment in which the comparison medium was water. Correction for the depression of the thermal neutron density by the indium foils was made by use of Bothe's formulas.[2]

In these experiments the silicon cross section was compared with the hydrogen cross section for absorption. Correction for other nuclei was made by assuming σ_a(oxygen) = 0.0016 barn and σ_a(carbon) = 0.0045 barn.[3] Impurities were negligible.

From the experiment in which sand-water was compared with carbon-water,

$$\sigma_a(\mathrm{H})/\sigma_a(\mathrm{Si}) = 2.3\pm20 \text{ percent.}$$

From the one in which sand-water and water were compared,

$$\sigma_a(\mathrm{H})/\sigma_a(\mathrm{Si}) = 2.0\pm15 \text{ percent.}$$

Errors shown are estimated probable errors based on reasonable values of uncertainties in the corrections, concentrations, and space integrals. The weighted average of the two determinations is

$$\sigma_a(\mathrm{H})/\sigma_a(\mathrm{Si}) = 2.1\pm12 \text{ percent.}$$

If σ_a(H) is taken to be 0.313 ± 0.013 barn[3] at the standard neutron speed of 2.2×10^5 cm/sec.,

$$\sigma_a(\mathrm{Si}) = 0.15\pm0.02 \text{ barn.}$$

The calculations have neglected the possibility of resonance absorption in Si. An experiment to search for resonance absorption showed that the resonance escape probability $p = 1.01$, i.e., 1.00 within the experimental uncertainty of about 2 percent.

* The experimental work reported here was done at the Massachusetts Institute of Technology, Cambridge, Massachusetts, in connection with the Nuclear Shielding Project, which is supported by a joint program of the ONR and the BuShips.
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The Gamma-Ray Spectrum of Ba^{131}

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THE Ba^{131} photo-electron spectrum from a lead radiator has been investigated below 700 kev. A thin lens spectrometer adjusted for two percent resolution was used. The spectrometer calibration constant was 598.9 gauss-cm/amp. This was determined by measuring the K and L photo-electron peaks of the

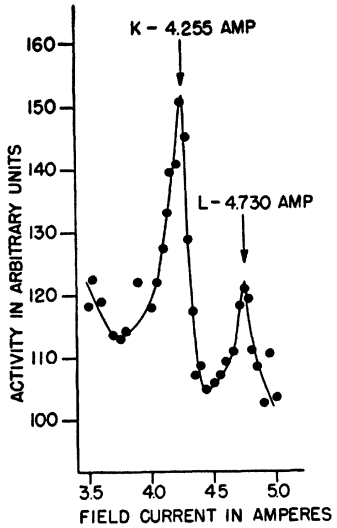

FIG. 1. Ba^{131}—496.5-kev peaks.

364.18-kev gamma-ray in I^{131}. The energy of this gamma-ray is known[1] accurately and lies in the region of gamma-ray energies of Ba^{131}. The calibration was repeated with gamma-rays of Co^{60} and found to be within 0.05 percent of that of I^{131}.

Activated barium nitrate was obtained from the Oak Ridge National Laboratory. The sample was purified and the cesium removed chemically. Since the material had a low specific activity a large volume of sample (about one cubic centimeter) was used. The total activity after decay of Ba^{133} at the beginning of observations was about 0.5 millicurie. The spectrum was found to complex. The peaks occurring at current settings 4.255 ± 0.01 and 4.370 ± 0.02 amp. were much stronger and better defined than any of the others. These are shown in Fig. 1. The separation and relative intensity of the two peaks indicate that they are the K and L peaks of a single gamma-ray.

Values for the gamma-ray energy calculated from the K and L photo-electron peaks are 496.5 ± 1 kev and 496.5 ± 2 kev.

The high background due to the large sample caused considerable uncertainty in the analysis of the other peaks. There was a substantial increase in the counting rate corresponding to photo-electron energies in the range from 95 to 130 kev. The distribution was too broad to be due to either the K or the L photo-electrons from a single gamma-ray energy. The shape of the distribution indicated the superposition of photo-electrons from at least three gamma-ray energies.

A grant in aid from the Ohio State University Development fund for construction of a thin lens spectrometer made this work possible and is gratefully acknowledged by the authors.

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On the Radioactivity of Potassium

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IT is known that K^{40} decays into Ca^{40} through β^- emission; v. Weizsacker[1] suggested that it may also decay into A^{40} through β^+ emission or K-capture. β^+ radioactivity was excluded by an experiment due to Bothe[2] and K-capture was apparently demonstrated first by Thompson and Rowlands, and then by Bleuler and Gabriel,[3] who gave for the ratio λ_K/λ_- the figure 1.9 ± 0.4. Doubts on the reliability of this result and of the value $\lambda_-=1.0\times10^{-9}$ yr.$^{-1}$ given by the same authors were raised in different places.[4] Direct search[5] for A^{40} in old potassium ore showed quantities which are far inferior to those expected on the basis of the value given by Bleuler and Gabriel and suggests for λ_K/λ_- a maximum possible value of 0.1.

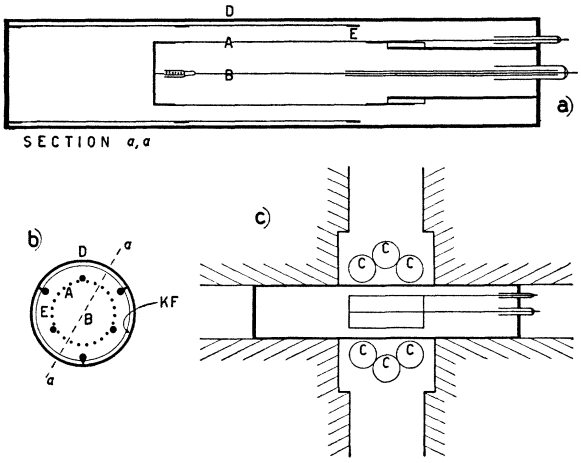

FIG. 1. Experimental arrangement.

We made first an investigation[6] on β- and γ-radiation from K^{40} with an experimental arrangement which was derived from those of Occhialini, Bocciarelli, Libby, and Lee.[7] Then, as we describe below, we tackled the problem of the K-capture with other equipment, similar to that used by Bleuler and Gabriel, but with an essential improvement, in the addition of a magnetic field which eliminates the background due to β-rays (which outnumber by far the x-rays looked for) and an anticoincidence system which substantially reduces the background due to cosmic rays.

The experimental arrangement is shown in Fig. 1, *a* and *b*. A and B are respectively the cathode and the anode of a Geiger-Müller counter, 58 mm in diameter, the effective length of which is 140 mm; the cathode consists of a parallel system of brass wires 0.3 mm thick at a distance of 4 mm from each other. The counter is coaxial with the tube D, 95 mm in diameter and 500 mm long. On the internal surface of D and facing the counter is deposited a layer of KF, 2.5 mg/cm^2 thick and 140 mm long. The movable frame E is covered half (140 mm) with an aluminum foil 0.03 mm thick, and half with a net of wires 0.1 mm in diameter. The frame can be moved by inclining the tube in order to insert either the foil (which is supposed to absorb completely the soft x-rays from A^{40}) or the net between the KF layer and the counter. Both electrodes of the counter are insulated, and the cathode A is maintained at a potential about 300 volts negative with respect to the tube D. This is necessary to restrict the sensitive volume of the counter to the space inside A, by preventing the entry of electrons generated outside. The counter is located between the pole pieces of an electromagnet, taking advantage of a hole along its axis (Fig. 1*c*). The field, parallel to the axis of the cylinder and uniform in the region used in the experiment, is regulated so as to prevent β-rays from penetrating to the inside of the counter. Actually the pulse frequency decreases by increasing the field up to 6000 gauss and then remains constant. In our experiment we used a field of 10,000 gauss. Calculation shows then that β-particles from the KF layer cannot come nearer than 5 mm to the cathode of the counter. Residual pulses are therefore due either to more energetic, or to field-insensitive rays, mainly cosmic, γ- or possibly x-rays. The six counters C, in parallel with each other, are in anticoincidence with the counter AB.

After some trials with various gas mixtures, a filling with 400 mm Hg argon and 10 mm Hg ethyl alcohol proved the most satisfactory. The calculated efficiency of this filling for the argon x-rays is about 0.48. Taking into account the average absorption in the KF layer (0.50) and in the gas between this layer and the cathode