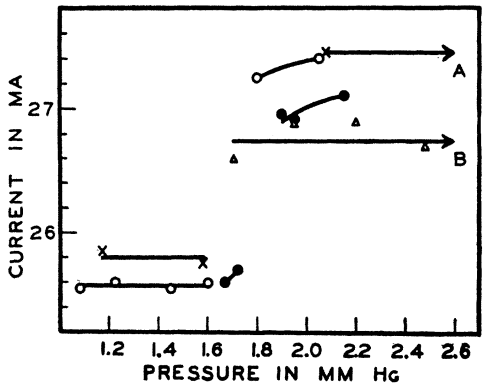

FIG. 2. Tube current as a function of gas pressure. Other data (not shown) indicate that curves *A* and *B* extend, at constant current, to 9-mm Hg and 4-mm Hg, respectively.

whiter. This abrupt change occurred in addition to the gradual change to a whiter discharge (as pressure is decreased) which takes place at higher gas pressures. The latter is probably due to the relatively late saturation of the intensity-pressure curve for the strong yellow line at 5875A. The abrupt change may likewise be connected with this line since the blackening-pressure curve has a large slope in this region (Fig. 1).

The large current change at about 1.7-mm Hg may account for the large change in sputtering rate, since sputtering increases with voltage.[7] The voltage increase, corresponding to the current decrease (negative linear current-voltage characteristic), was observed to be as abrupt as the latter. The determination of this critical gas pressure can be used to ascertain both operating and sealing-off pressures of high intensity, low pressure discharges where the sputtering rate must be small.

* Now at the University of Kentucky, Lexington, Kentucky.
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On the Measurement of the Energy of Fast Neutrons by Photographic Emulsions Loaded with Enriched Li^6

GEORGE R. KEEPIN AND JAMES H. ROBERTS
Department of Physics, Northwestern University, Evanston, Illinois
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IN the literature[1] it is suggested that Li^6 disintegrations in photographic emulsions be used to measure the energy of fast neutrons. In commercial lithium loaded plates the disintegrations are masked by a high background of proton tracks. To overcome this Roberts[2] suggested the use of emulsions heavily loaded with enriched Li^6. This isotope with an enrichment factor of about 98 percent was supplied to the Los Alamos Scientific Laboratory by the Carbide and Carbon Chemical Corporation of Oak Ridge, Tennessee. The Eastman Kodak Company impregnated the enriched Li^6 into NTA type emulsions.

Some of these plates have been bombarded with neutrons from a mixed Po+Be source at the Argonne National Laboratory. Figure 1 shows a disintegration produced by a neutron from this source.

About 225 tracks produced by thermal neutrons from the thermal column of the heavy water pile at the Argonne National Laboratory were measured giving $R_\alpha = 6.8 \pm 0.6\mu$ and $R_T = 38.2 \pm 1.1\mu$. An analysis of the method indicates that it can be used to measure neutrons of energy less than one Mev to a precision of at least ± 0.1 Mev; preliminary measurements with monoenergetic neutrons confirm this. Such resolution is obtained as follows:

For a given neutron energy and angle θ between the alpha-particle and triton there are in each disintegration two possible triton energies. Select those disintegrations for which the triton has the greater energy. The disintegrations so selected must now be considered individually according to the value of the angle θ. As θ decreases from 180° to its limiting value, the neutron energy becomes an increasingly sensitive function of θ. Thus for tracks with θ greater than say 170° the neutron energy can be determined from an accurate measurement of the sum of ranges of the two particles and a rough determination of the angle. For tracks with successively smaller θ values it is necessary to determine θ with increased accuracy in order to obtain the neutron energy with the same precision. The method is being tested at Northwestern to measure the energy of neutrons from a thin beryllium target bombarded with polonium alpha-particles.

The Li^6 technique will extend the photographic method to neutron energies below one Mev. It is particularly suited to the measurement of the energy distribution of fast neutrons inside a material medium since collimation of the neutrons is not required and perturbations introduced by the detector are minimized.

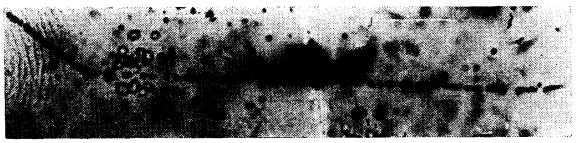

FIG. 1. Li^6 disintegration by a neutron from a mixed Po+Be source. $R_\alpha = 17.5\mu$, $R_T = 86.2\mu$, and $\theta = 149°$. Approximate range energy curves and $Q = 4.64$ Mev give a neutron energy of 4.6 Mev.

The results of this study of the method together with some specific applications will be published in detail at a later date.

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The Effect of Alpha-particles on a Superconductor*

D. H. ANDREWS, R. D. FOWLER AND M. C. WILLIAMS
Chemistry Department, The Johns Hopkins University, Baltimore, Maryland
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SUPERCONDUCTING bolometers have been bombarded with alpha-particles from a polonium source, and it is found that countable electrical pulses are produced, one for each particle impact. The bolometer used in the experiment reported here was made of a strip of columbium nitride, approximately $3.5 \times 0.4 \times 0.006$ mm, mounted with bakelite lacquer on a copper base, and maintained at the operating temperature of 15.5°K in a cryostat, as previously described;[1] its time constant was about 10^{-3} sec.

To provide a mounting for the polonium source, a glass tube *ca.* 30 cm long and 3 cm diameter was sealed to the cryostat nose facing the bolometer. The source could be slid back and forth in this tube, placing it at distances from the bolometer ranging from 2 cm to 20 cm.

The source consisted of polonium on a nickel disk 1 cm diameter, attached to the face of a steel cylinder. A vacuum of better than 10^{-6} cm was maintained in the source tube and around the bolometer by a charcoal trap at liquid nitrogen temperature aided by the many contiguous surfaces at 15°K, so that the α-particles traveled from the source to the bolometer with no significant loss

TABLE I. Comparison of α-particle counts with ionization chamber and bolometer.

Distance from source to defining area: Average counts per second:	20 cm	2 cm
(a) Ionization chamber	40	740
(b) Bolometer	32	660

of energy. The bolometer was protected from general heat radiation by a shield held at 90°K. The α-particles passed through a hole in this shield, the opening being 7 mm diameter, in alignment with the bolometer.

The bolometer was connected to a direct current supply, and by potential leads to the primary of an audio transformer, the secondary of which led to a pulse amplifier, and thence to an oscilloscope, and scale-of-1000 counter.

The rate of counting was at a maximum when the CbN was maintained in the center of the transition, half-way between normal and super conductivity; it was relatively constant over a central interval 0.04° wide and fell sharply both above and below this temperature zone, being reduced approximately to noise level by an increase or decrease of 0.1°K. The electrical resistance of the strip was 2ω in the normal state at 15°K.

The number of counts per second was also a function of the direct current flowing through the CbN, being at a maximum for a current of 40 ma.

The number of α-particles counted with the bolometer agreed, as shown in Table I, with the number counted with an ionization chamber and linear amplifier when the ionization chamber was exposed to the source through a slit system similar in geometry to that in the bolometer experiments. The ionization chamber slit was covered with a thin mica window, and the air pressure in the source tube kept at 0.01 mm.

From photographs of the peaks on the oscilloscope it is estimated that each individual pulse from the bolometer is about 10^{-7} volt high and 10^{-4} second wide. The maximum signal to noise ratio was 3 to 1. Since the pulse height may be expected to be proportional to the energy of the α-particle, experiments are being continued to increase the signal to noise ratio, in order to evaluate the precision with which the energy of individual particles can be measured by this method, and to determine the kind of pulses produced when superconducting bolometers of this and other materials are exposed to different kinds of particle radiation. The authors wish to thank Professor Walter Koski and Mr. Carl Thomas for valuable advice and assistance.

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Uranium^{235} in Thucholite

J. B. ORR
R. F. D. No. 3, Great Barrington, Massachusetts
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THE radioactive mineral Thucholite occurs in certain pegmatite dikes in the Parry Sound district of Ontario, Canada. It contains, along with uranium and thorium, considerable carbon.[1] Since the mineral, including carbon, was apparently of igneous origin, it was thought that, if it had originated from a mass of sufficient size, the carbon acting as a moderator of fission neutrons, a chain reaction might at one time have taken place. If this were the case, it was thought that there might exist *versus* normal uranium a difference in the amount of U^{235} fissionable by slow neutrons.

Samples of thucholite were obtained from the Besner Mine, Henvey TWP., Ontario, Canada. A 2g sample was powdered, ashed and weighed. Loss including carbon and volatiles was 26.5 percent. A 2.5g sample was powdered, decomposed with HF and dissolved in HNO_3. The residue was dried and weighed and then ashed and weighed. The loss consisting largely of carbon was 21 percent of the original sample. Filtrates from acid solution of both samples were added and U precipitated as uranyl ammonium nitrate after extraction of the sulfide group, Fe, Th, Al, and Pb. The uranium was reduced to the green oxide and tested for purity by dissolving a small amount in glacial acetic acid. No visible residue remained. Total U_3O_8 was 7.2 percent of the original samples. U_3O_8 was similarly extracted from a sample of uraninite from the Ruggles Mine, Grafton, N. H. Both U_3O_8 samples were finely powdered and mixed with 10 percent by weight of Amphenol 912 and sufficient solvent to make a mixture which could readily be painted on pieces of Al foil 10 cm×15 cm×4.5 mg/cm^2 thick. The average thickness of U_3O_8 was 2 mg/cm^2. Foils prepared as above were laid over an air counter.[2] The counter was only 40 percent efficient for U^{238} and U_{234} alphas. However, the Ruggles sample showed a 10 percent greater count than the thucholite sample. 1.8 kg of paraffine were placed on top of the foil and counter with a 1 mc Ra-Be neutron source imbedded in the paraffine 4.75 cm from the foil. The counter pulses were fed into an amplifier, discriminator and scale of 64 counter. Considerable difficulty was experienced in reducing the background due to spurious pulses over the surfaces of the counter insulators. However, by continually passing dried air through the counter these were reduced to 0.05 counts per min. with the samples and paraffine in place but with the neutron source removed. Fission counts by this set up are shown in Table I.

TABLE I. Experimental data.

Sample	Air counter fission counts/min.	Ionization chamber fission counts/min.	Av.
Ruggles	0.52±0.123	0.38±0.088	0.44±0.07
Thucholite	0.18±0.08	0.20±0.078	0.19±0.05

Because of the difficulties experienced with the air counter and as a check of the instruments used, the foils were reduced in size to 9.5 cm×12.4 cm so they could be placed inside a propane filled ionization chamber. The positively charged collector plate was 1.9 cm from the grounded foil. Paraffine and the neutron source were placed on top of the foil but outside the ionization chamber with a geometry identical to the former experiment. Pulses were fed into a preamplifier and video amplifier with a clipping time of 2 microseconds and from there to a discriminator and 64 scaler. The alpha-counting rate was too high for the mechanical register to handle but a rate meter read approximately 92,000 counts/min. on the Ruggles foil and 84,000 counts/min. on the thucholite sample. The fission counts are included in Table I.

The work completed so far is only preliminary and suffers from too slow a counting rate and insufficient data. Although the masses of the samples were within ½ of 1 percent of each other, the alpha-count of the Ruggles sample was 10 percent high due either to contamination with other alpha-emitters or impurities in the thucholite sample. However, 10 percent impurities in the thucholite would be insufficient to account for the difference in fission counts. There is a possibility that the thucholite sample was contaminated with large amounts of Th which would reduce the fission count without reducing the alpha-count. However this seems hardly probable. The experimental data would seem to warrant further work.

It would be interesting to examine the isotope ratios of the rare earth elements contained in the mineral as well as the ratios of isotopes of other minerals in the dike.

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