chrysene in a Dewar flask precipitated colorless rhombic crystals averaging 5×5×0.5 millimeters. Preliminary tests with one- and two-thickness layers of these crystals and with smaller crystals showed that the originals were about optimum size for low energy beta-counting; i.e., 150 kev and less. No attempt was made to make larger crystals although it is assumed that it could be accomplished by the method of Feazel and Smith.[1]

Anthracene crystals were precipitated in the same manner as above but large size crystals were not obtained. A comparison was made between the small anthracene crystals so obtained and chrysene crystals of comparable size. The counting rates, using C^{14} as a source, showed chrysene to be slightly more efficient than anthracene. A one-layer screen of the large chrysene crystals gave appreciably greater counting rates than for the small anthracene crystals.

The scintillation counter employed a 1*P*21 photomultiplier tube with 75 volts on each of the first two dynode stages and 100 volts on each of the last seven. A gain of from 5 to 10 percent in the signal-to-noise ratio was found by decreasing the voltage between dynode nine and ground from 50 to 5 or 10 volts. The pulses were fed into a cathode follower and then into a Los Alamos model 501 amplifier, using a gain of about four hundred. All data were taken at room temperature.

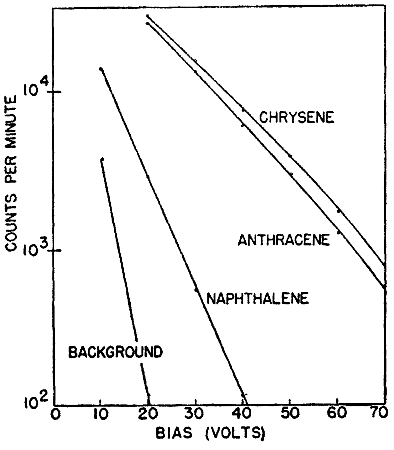

FIG. 1. Comparison of Koppers naphthalene, small anthracene crystals, and large chrysene crystals using an uncollimated C^{14} source. Counts per minute are plotted against bias. All rates are with background subtracted.

With the same values of the circuit parameters as above, efficiency tests were made. The C^{14} source, roughly collimated, when placed next to the window (1.93 mg/sq. cm) of a Tracerlab G-M counter, produced two thousand counts per minute. The chrysene scintillation counter, using the same collimated source, had the same efficiency when the counter bias was adjusted to admit a background of sixty counts per minute. Lowering the bias to admit four hundred background pulses per minute gave a counting rate (with background subtracted) 1.4 times the G-M rate (see Fig. 1).

Efficiency tests were also made on the beta-rays of Co^{60}. A screen two crystals deep was found to be the optimum thickness for this source, but the efficiency of the scintillation counter could not be made equal to that of the G-M counter unless a background of 450 pulses per minute was admitted. This high rate is undesirable especially since the actual counting rate was only one thousand counts per minute over background. The apparent inefficiency of the scintillation counter for these energies (300 kev and less) is undoubtedly due to loss of light by reflection from the crystal faces. Crystals of about one millimeter thickness should bring the efficiency of the scintillation counter to a more practical value.

The chrysene scintillation counter was used to detect the internally converted electrons from Rh^{103*} (about 40 kev). A weakly activated sample (x-ray excited) gave counting rates slightly greater than twice background at an optimum bias setting.

This work was supported by the joint program of the ONR and the AEC.

---

* AEC Predoctoral Fellow.

[1] C. E. Feazel and C. D. Smith, Rev. Sci. Inst. 19, 817 (1948).

Neutron Yield from $Li^7(p, n)Be^7$

G. FREIER, E. E. LAMPI, AND J. H. WILLIAMS
University of Minnesota, Minneapolis, Minnesota

January 13, 1949

SINCE the reaction $Li^7(p, n)Be^7$ is used extensively as a monochromatic source of fast neutrons, we have studied the yield from the threshold, 1.88 Mev to 3.66 Mev to determine whether there exists more than one group of neutrons. It has been reported[1] that a resonance occurs at 3.06 Mev with the possibility that this is due to an excited state of Be^7.

The Minnesota Van de Graaff generator was used to accelerate protons up to 3.66 Mev with an energy control of ±5 kev. The lithium target was evaporated on a 0.010-inch thick rotating backing. The target was measured to be 24 kev thick.[2] The measurements of the neutron yield

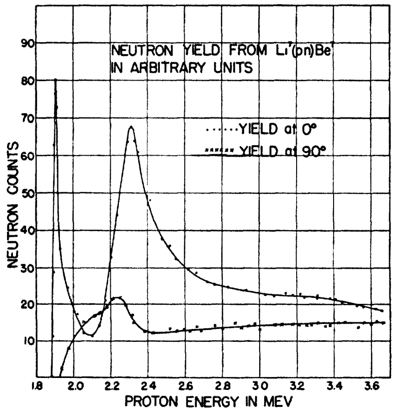

FIG. 1. The neutron yield at 0° and 90° as measured with a flat energy response detector. The statistical deviations are ±2.5 percent at 2.8 Mev in the 0° curve and +4.0 percent in the 90° curve.

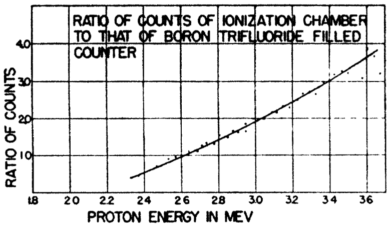

FIG. 2. The ratio of counts in an ionization chamber to those in a boron trifluoride counter covered with paraffin. The statistical deviations are ±6.4 percent at 2.8 Mev.

at 0° and 90° were taken with a flat energy response detector similar to the one described by A. O. Hanson and J. L. McKibben.[3]

The yield at 0° was measured with the counter $13\frac{1}{4}$ inches from the target. In this position it subtended a solid angle of 0.28 steradian. At 90° the counter was placed 31 inches from the target. Figure 1 shows the yield at 90° and 0° as measured with the flat energy response counter. The large solid angle at 0° distorts the first peak in the curve. The results agree fairly well with those of Taschek and Hemmindinger.[2] No evidence for additional resonances as reported by Hill and Shoupp[1] were found.

In an attempt to find more than one group of neutrons, a comparison was made of the yield at 20° as measured simultaneously with an ionization chamber and a boron trifluoride-filled counter surrounded with a two-inch layer of paraffin. The argon-filled ionization chamber with a thin paraffin radiator was designed to detect only fast neutrons of energy greater than 0.6 Mev. Since the ionization chamber efficiency increases with neutron energy and the boron counter decreases with neutron energy, it was felt that an excited state of Be^7 would result in a discontinuity in the ratio of counts in these two detectors at an incident proton energy just sufficient to produce this excited state. Figure 2 shows the ratio between the neutron counts in the ionization chamber and the boron trifluoride counter as a function of the proton energy. No anomalies were found. We conclude that to within the accuracy of our measurements there is only one group of neutrons emitted in this reaction up to a proton energy 3.66 Mev.

This research was done under the partial support of the ONR, Contract N5ori-147.

[1] J. E. Hill and W. E. Shoupp, Phys. Rev. **73**, 931 (1948).
[2] R. Taschek and A. Hemmindinger, Phys. Rev. **74**, 373 (1948).
[3] A. O. Hanson and J. L. McKibben, Phys. Rev. **72**, 673 (1947).

Measurement of the Proton Moment in Absolute Units

HAROLD A. THOMAS, RAYMOND L. DRISCOLL, AND JOHN A. HIPPLE
National Bureau of Standards, Washington, D. C.
January 10, 1949

THE absolute value of the magnetic moment of the proton has been determined by measuring the magnetic field and frequency required for nuclear resonance absorption in a proton sample. The nuclear resonance technique is similar to that developed by Purcell[1] and his collaborators but has a modified circuit design. The sample is water with the relaxation time adjusted to an optimum value by the addition of ferric oxalate.

An electromagnet having auxiliary coils in addition to the main exciting windings was used to produce a field of about 5000 gauss in a 2-inch gap having approximately rectangular pole pieces $8\frac{1}{2}$ inches by $12\frac{1}{2}$ inches. The field distribution in the gap was obtained by using two nuclear resonance probes, one to plot the field and the other to regulate the field by means of a phase detector and power amplifier supplying the auxiliary coils. After shimming, field variations throughout the volume used did not exceed one part in 10,000 and they were accurately plotted. By means of a balance the value of the field at the center of the gap was measured from the force produced on straight conductors 10 cm long which carried a known current. These conductors form one side of a rectangular coil whose opposite side is 70 cm above the center of the gap. The stray field at the upper end of the coil was reduced to zero by a pair of large diameter Helmholtz coils. The accuracy of the measurement of the field by this means was limited principally by the uncertainty in the length of the conductors which was one part in 20,000.

During the measurement, the field was regulated to within 0.02 gauss by one resonance probe which had a local field bias such that the field at the center of the gap where the conductors were located was the exact value required for proton resonance. This could be checked before and after each field measurement by using the other probe. Both resonance probes were supplied from a 20-mc crystal oscillator, and the frequency was measured to a few parts per million by heterodyning the oscillator with the NBS standard frequency station WWV.

The values of field and frequency thus measured give a value for the gyromagnetic ratio of the proton of

$$\gamma_p = (2.6752 \pm 0.0002) \times 10^4.$$

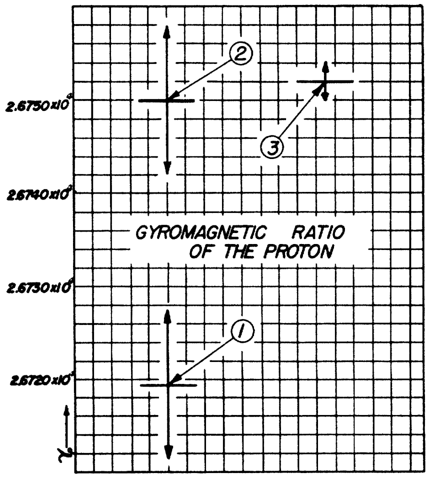

FIG. 1. (1) indicates the value of the gyromagnetic ratio of the proton reported by Millman and Kusch (reference 3). (The error does not include any uncertainty in the value of m/M); (2) shows the value of Millman and Kusch with the radiative correction to the electron moment (see references 4 and 5); (3) is the value reported here.