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ANGULAR DISTRIBUTION OF NEUTRONS FROM THE BOMBARDMENT OF BE BY 340 MEV PROTONS

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Angular Distribution of Neutrons from the
Bombardment of Be by 340 Mev Protons

James DeJuren

June 26, 1950

Berkeley, California

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Angular Distribution of Neutrons from the
Bombardment of Be by 340 Mev Protons

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June 26, 1950

In conjunction with the measurements of Miller, Sewell and Wright¹ of the angular distribution of the neutrons produced by the bombardment of various targets with 330 Mev protons, a measurement was made using bismuth fission chambers^{2,3} as detectors instead of the carbon (n,2n) reaction employed by the above group. Bismuth fission has its threshold at a neutron energy of about 50 Mev compared to 20 Mev for the C(n,2n) reaction. The data from 15° to 27° were taken using the neutrons produced from the bombardment of a 2.8-inch Be target with 330 Mev protons inside the cyclotron immediately after the C(n,2n) measurements. Shallow fission chambers containing two 4.5-inch diameter bismuth coated plates were employed as monitor and detector. The 8° result was obtained from the bombardment of a 2-inch Be target with 350 Mev protons at the standard probe position.

To extend the angular range, measurements were made with the neutrons knocked out of a 1 11/16-inch diameter beryllium rod by the electro-magnetically deflected, external 345 Mev proton beam. Since the fission counting rate was only about 70 counts per hour at 12° it was necessary to find the fission pulse height distribution by means of a pulse height analyzer (for

¹ R. Miller, D. Sewell, and R. Wright (to be published)

² C. Wiegand, Rev. Sci. Instruments 19, 790 (1948)

³ J. DeJuren and N. Knable, Phys. Rev. 77, 606 (1950)

the loan of which I am indebted to Clyde Wiegand), to insure that "pileups" were not occurring during the 0.1 microsecond deflected proton pulse. Satisfactory plateaus were obtained with the long bismuth fission counters previously employed for the 95 and 270 Mev neutron energy measurements of nuclear cross sections.³

The distance from detector to target was such that the angular resolution was within $\pm 1^\circ$ of the indicated setting except at 62° and 85° where it was $\pm 2^\circ$. No attempt has been made to correct for neutron background scattered into the detector or produced by protons at regions other than the beryllium target. Four inches of lead were placed in front of the detector to prevent protons from entering it. The measured angular distribution is shown in the figure, and the statistical errors indicated are standard deviations based on counting.

If the angular distribution is graphically integrated the resultant total cross section for production of a high energy neutron is

$$\sigma_t = 1.05 \left(\frac{d\sigma}{d\omega} \right)_0$$

The neutron yield in the forward direction has been measured by Knox⁴ for the neutrons knocked out of Be with 350 Mev protons using the same fission chambers. His result is $\left(\frac{d\sigma}{d\omega} \right)_0 = 42.2 \times 10^{-27} \times \frac{\sigma_{p,pn}(350 \text{ Mev})}{\sigma_{n,2n}(270 \text{ Mev})}$ where the indicated cross sections are for carbon. Using 38 and 17 millibarns for the carbon (p,pn)⁵ and (n,2n)⁶ cross sections respectively the value of the total cross section is 100 millibarns (with an estimated accuracy of 50 percent). The total collision cross section for 270 Mev neutrons and a Be nucleus is 230 millibarns, as measured with bismuth fission detectors.

⁴ W. Knox, UCRL-440

⁵ L. Aamodt, V. Peterson, and R. Phillips, UCRL-526

⁶ L. Baumhoff (theoretical estimation)

FIG. 1