A: $a = 1.0 \times 10^{-13}$ c; B: $a = 0.5 \times 10^{-13}$ c. Full lines, exchange forces; broken lines, symmetric forces

ANGULAR DISTRIBUTION OF SCATTERING OF 100 MEV. NEUTRONS BY PROTONS

A new method¹ for determining the phase shifts of the partial waves enabled the contribution to the phase of the potential within a distance of $4a$ from the origin to be rapidly obtained, the correction for the remainder of the potential coming from a perturbation calculation. For the two ranges, phases beyond $l = 4, 8$ respectively could be neglected.

The differential cross-sections for the two cases are shown on a logarithmic scale in the accompanying diagram. It is seen that even for the energy considered, the type of force has little effect on the shape of the differential cross-section, or on the total cross-section, which is of the order $0.09, 0.13 \times 10^{-24}$ cm.² for the two ranges respectively. These results are similar to those published recently² for a lower range of energies and a square-well potential.

F. C. BARKER

Department of Mathematical Physics,
University, Birmingham. March 18.

¹ Ferretti and Krook, *Proc. Phys. Soc.* (in the press).

² Camac and Bethe, *Phys. Rev.*, **73**, 191 (1948).

Comparison of Cross-sections for the Capture of 220 and 900 keV. Neutrons

We have compared the capture cross-sections of a number of nuclei, for neutrons of 220 and 900 keV. The neutrons were produced by placing 400 mc. of radiothorium (contained in a platinum cylinder 5.5 mm. high and 5.5 mm. in diameter) inside either a beryllium cylinder (height 2.3 cm., wall thickness 9 mm.) or a cylindrical brass vessel containing heavy water (height 15 mm., wall thickness of D₂O 5.75 mm.). The photo-neutrons obtained thus are fairly monokinetic; but owing to the conservation of momentum they are spread out over an energy interval of 57 keV. in the case of heavy hydrogen and 25 keV. in the case of beryllium. (G. D. Latyshev¹ published new measurements of the thorium (C'') gamma-rays which show that besides the main line at 2.62 MeV. there exists a line at 2.2 MeV. the rela-

tive intensity of which is 5 per cent as compared to the main line. This line gives rise in the case of heavy hydrogen to neutrons of only 10 or 20 keV.; but an estimate of the cross-section of the photo-effect on that region shows that the total number of these slow photo-neutrons will not be more than 1.5 per cent of those of 220 keV. energy.)

Considerable care has to be taken to avoid slowing down of the photo-neutrons due to the moderating influence of the surrounding materials. The samples were irradiated inside an asbestos hut on the laboratory roof. It was found that irradiation inside the hut produced the same amount of artificial radioactivity as irradiation outside. Under these conditions, slowing down can still occur in the heavy water or beryllium itself. It was found, however, by reducing the amount of heavy water to one quarter of the quantity used in the main series of measurements, that this effect is negligible under our conditions, except in the case of indium, where a correction of 12 per cent had to be applied.

The samples for irradiation were, so far as possible, used in the form of foils bent to a cylinder 2.8 cm. high and 2.8 cm. in diameter, in the middle of which the source of photo-neutrons was placed for irradiation. Powders were filled into a double-walled-cylinder of brass placed around the neutron sources.

The ratios of cross-sections were obtained by irradiating the same sample of each element in turn with each of the two photo-neutron sources. The relative number of neutrons produced by the two sources was determined separately². The ratio of the intensity of artificial radioactivity obtained in the two irradiations, with a small correction, leads thus to the ratio of the cross-sections. The correction of 6.5 per cent was applied to allow for the anisotropy of neutron emission from the heavy water; it was obtained empirically.

Active isotope	²⁶ Al	⁵⁶ Mn	⁶⁴ Cu	⁶⁶ Cu
Ratio of cross-sections	1.7±0.5	2.3±0.6	1.0±0.2	1.3±0.5
Active isotope	⁷⁶ As	⁸⁰ Br. 18 min.	⁸⁰ Br. 4.4 hr.	⁸² Br.
Ratio of cross-sections	3.7±0.4	2.0±0.4	1.8±0.3	2.2±0.4
Active isotope	¹⁰⁴ Rh 94 sec.	¹⁰⁴ Rh 4.2 min.	^{106,108} Pd	¹¹¹ Pd
Ratio of cross-sections	3.1±0.8	2.2±0.8	2.0±0.3	1.1±0.3
Active isotope	¹⁰⁸ Ag	¹¹⁰ Ag	¹¹⁰ In 54 min.	¹¹² Sb
Ratio of cross-sections	2.0±0.3	1.00±0.2	0.8±0.1	1.2±0.1
Active isotope	¹²⁹ I	¹³⁰ Ba	¹³² Te	¹³³ Dy
Ratio of cross-sections	1.7±0.3	1.9±0.7	1.3±0.4	1.0±0.15
Active isotope	¹⁸⁷ W	¹⁹³ Pt	¹⁹⁸ Au	
Ratio of cross-sections	1.3±0.3	2.5±0.6	1.0±0.1	

The ratios of cross-sections are given in the accompanying table, from which it is seen that $\sigma_{220}/\sigma_{900}$ varies only between 1 and 4.

These results can be compared with the theory of Fishbach, Peaslee and Weisskopf³; the values for $\sigma_{220}/\sigma_{900}$ predicted by these authors vary still less than our results. In particular, their theory does not predict ratios of the order of 1 as we observe them in several cases.

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R. ALLEN
G. R. BISHOP

Clarendon Laboratory,
University, Oxford.

Institut de Physique,
Université de Montreal.
March 23.

P. DEMERS
H. HALBAN

¹ *Rev. Mod. Phys.*, **19**, 132 (April 1947).

² Amaldi, Hafstad and Tuve, *Phys. Rev.*, **51**, 896 (1937).

³ *Phys. Rev.*, **71**, 156 (1947).