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RESEARCH PROGRESS MEETING

May 27, 1948

R. K. Wakerling

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Neutron Scattering. A. Bratenahl.

The experiments on the scattering of 90 Mev neutrons have continued with the use of proportional counters in coincidence as detectors. It will be recalled that in the early work stacks of carbon plates were used as detectors. The results for the two methods of measurement agree quite well. However, there exists a difference between the differential scattering cross sections as measured with either system and those predicted by diffraction theory treating the nuclei as opaque obstacles of radii measured by McMillan et al. Intensities in the scattered angles investigated ($0^o - 10^o$) are higher than the simple diffraction theory would predict. If the tail of the scattering curve is assumed to give the measure of the inelastic scattering and this is subtracted from the observed values, a much better agreement with theory is found.

In Figure 1 is shown schematically the set-up of the apparatus used. Proportional counters are used in triple coincidence with a 60 Mev absorber placed between the second and third counters. A lead house surrounds the counter system at one end and behind it is placed a transition thickness of paraffin for the generation of protons.

One of the major difficulties in the use of proportional counters is the large range of counting rates required. When the cou ers are first placed in the beam to measure its intensity and then placed in the field of scattered neutrons, the intensity range varies by a factor of a thousand. Since this type of counter system is limited to about 6400 counts per minute, some other system of monitoring the beam is necessary. The scheme presently employed involves the use of a BF_3 counter placed in the concrete shielding wall adjacent to the collimating hole through which the neutrons emerge. As a check another monitor counter is placed in the concrete igloo at some distance from the shielding wall. Because of the large range of counting rates that can be covered, low backgrounds and good plateaus, this system has been used with fairly satisfactory results. Adjustment of the beam strength is made to provide approximately the same counting rates in the coincidence proportional counters under all conditions, and the monitor counter takes care of the large range of counting rates required.

As mentioned above, the results obtained with this system confirm previous measurements with carbon detectors. In order to test the performance of this system good geometry attenuation data have been taken with copper over an intensity reduction of about 10,000. The half-value thickness found was between 1.6 and 1.7 inches, in agreement with values obtained by Knable using bismuth fission counter detectors. However, it does not agree with the value of 1.45 inches obtained with carbon detectors by McMillan et al. Measurements will be made of the total cross sections of a number of elements in the collimated beam with the coincidence proportional counter apparatus and with an energy threshold at 60 Mev.

Some further total cross section measurements were made outside the shielding with carbon detectors. The following table shows a comparison of these measurements with similar measurements of McMillan, and with others made using the proportional counter technique.

	σ_t (Carbon detectors)	σ_t (McMillan et al)	σ_t (Proportional counter)
Pb	4.74 b	4.53 b	4.53 b
Cu	2.32	2.22	2.12
C	0.535	0.550	0.54

Nuclear Cross Sections. Norman Knable.

Attention is again being given to the problem of measuring total cross sections by the use of bismuth fission counters. A considerable effort has been expended in attempts to improve the instrumentation. Particular care has been exercised in aligning the apparatus with the neutron beam. This was done by taking shadow radiographs of the beam with the apparatus in place. It is felt that this method is more accurate and reliable than that of using the optical system employed for aligning the cloud chamber. To illustrate (see Figure 2), the alignment is such that a brass cylinder placed in the beam as shown in the figure casts a well defined shadow on the photographic plate placed in front of the detector chamber, showing that the neutron paths are aligned parallel to the axis of the cylinder. Similar radiographs were taken with the apparatus in place and with the photographic plate placed at the end of the detector. This method is very quick and establishes with certainty the alignment of the system.

The detector consists of an ionization chamber 18 inches long containing 30 discs 2 inches in diameter. Alternate discs are coated with a 1 milligram per square centimeter deposit of bismuth. A 500 volt potential is established between alternate plates so that particles released from the bismuth are attracted to and deposited on the non-coated plates. Without the absorber in place 1280 counts per minute were obtained. By the use of thin bismuth coatings a plateau in the curve of the counting rate versus pulse height selector is obtained. Figure 3 shows a typical curve. The discriminator voltage is customarily used at 50 volts where the change of counting rate is only 1-1/2 percent per volt. Measurements conducted over a long period of time indicate that the discriminator voltage and the linear amplification are extremely constant so that the apparatus may be run without adjustment for considerable periods of time.

The scatterer, usually one mean free path in thickness, is placed at a distance of 8 feet from the detector so that the solid angle of scattering detected is only .0004 steradians. Initial measurements on attenuation in copper agree with those obtained by Bratenahl mentioned above, as well as with the early work done last year on this problem. The half-value thickness found was between 1.6 and 1.7 inches. Cross sections measured thus far are given in the following table as compared with earlier measurements of McMillan et al.

	McMillan	Attenuation measurement	Scattering through 1 MFP of material
H	.083 b	.079 b	
Be	.431		.396 b
C	.550	.450	.502
O	.765	.660	
Al	1.12	.957	
Cu	2.22	1.89	2.00
Sn	3.28	3.02	3.13
Pb	4.53		4.38
U	5.03	5.06	

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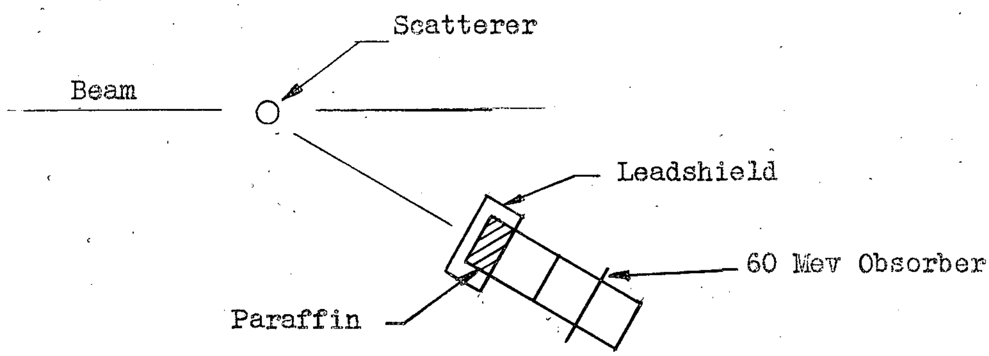

Figure 1

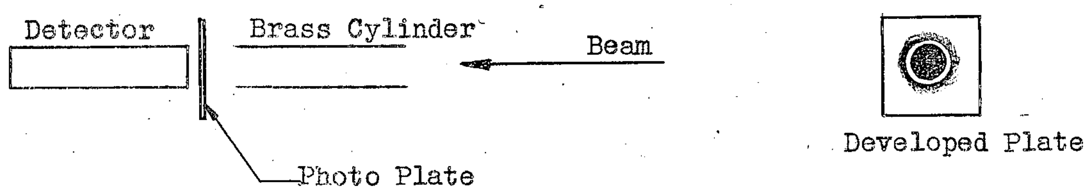

Figure 2

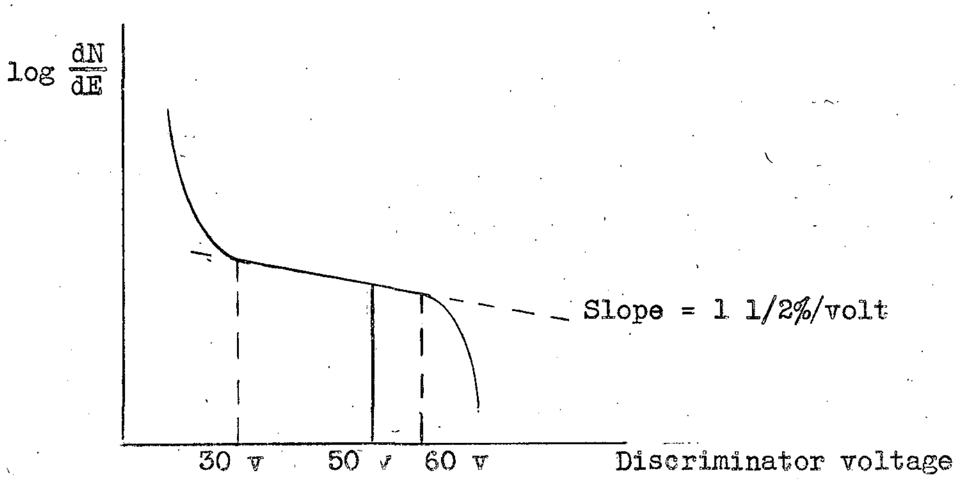

Figure 3

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