Total Cross Sections for High-Energy Neutrons*

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(Received May 3, 1954)

IN measurements of total cross sections for high-energy neutrons, detectors accepting neutrons of relatively wide ranges of energy have been used. By utilizing the known spectrum of the neutron beam and the threshold acceptance energy values of the detectors an effective energy has been stated to about 2 percent.[1] A scintillation counter telescope allows the use of considerably narrower energy acceptance bands in the determination of total cross sections.[2] The increased resolution of such a telescope makes it a suitable instrument to analyze the variation of total cross sections as a function of energy as well as permitting a more precise determination of the effective energy.

By means of such a telescope, a good-geometry attenuation experiment has been performed with neutrons produced from a $\frac{1}{4}$-in. beryllium target bombarded by the 110-Mev internal proton beam of the Harvard 95-in. synchrocyclotron.[3] The neutron beam, collimated by pipes of rectangular cross section (so chosen to give maximum counting rate for a given energy resolution), was first monitored by a triple coincidence scintillation counter telescope of neutron threshold energy approximately 35 Mev (Fig. 1). Then the neutron beam, attenuated by samples of various elements, passed through a second rectangular collimator and its intensity was determined by another scintillation counter telescope. The second telescope (which counted exchange protons following the conventional polyethylene-carbon subtraction method) consisted of 8 plastic scintillators mounted on 1*P*21 photomultipliers. Five, six, seven, and eightfold coincidences were used, with the resultant energy bands determined by range differences.

The values of the cross sections are listed in Table I.[4] The cross section of hydrogen was determined from a polyethylene-carbon subtraction, of deuterium from a heavy water-ordinary water subtraction and of oxygen by an ordinary water-hydrogen subtraction. It is to be emphasized that the energies quoted and the errors given are the absolute and not the effective values. The statistics of the cross sections are counting statistics only; other sources of error are believed negligibly small.

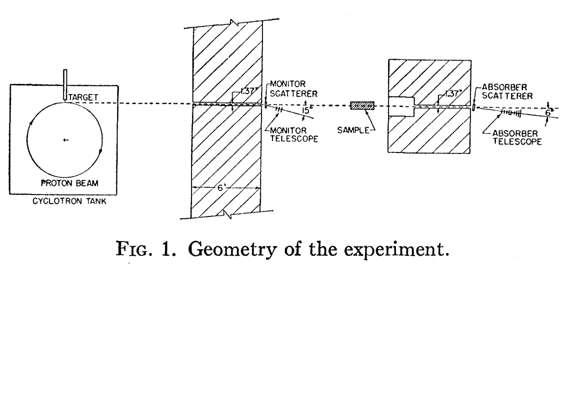

FIG. 1. Geometry of the experiment.

TABLE I. Total cross sections for neutrons. (10^{-27} cm^2).

Neutron energy (Mev)	94.8±1.5	98.6±2.5	102.0±0.76	107.9±5
Pb	4628±87	4595±63	4407±121	4736±209
Fe	1947±48	1874±37	1734±81	1946±184
Si	1136±52	1067±42	1041±92	925±218
Al	1067±29	1046±23	920±50	1064±126
O	721±13	675±9	649±14	668±42
C	518±6	494±4	466±7	508±18
D	110±7	108±5	81±9.9	62±21.9
H	77±5	76±3	80±7	59±16
Neutron energy (Mev)	77.7±1.3	82.2±3	86.8±1.4	100.7±12
Pb	4910±164	4957±98	4905±107	4569±46
C	614±31	585±17	602±19	518±7
Neutron energy (Mev)	61.5±1.7	66.8±3.5	72.1±1.7	93.5±19
Pb	4590±225	4551±160	4647±193	4605±121
C	674±62	671±42	601±41	521±79

In the case of lead, confirmation of the "Harwell dip"[1] is observed at the lower energy points.

Acknowledgments are due G. Tirellis and G. Bouchard for their assistance during the experiment and in the analysis of the data.

* Supported by a joint program of the U. S. Office of Naval Research and the U. S. Atomic Energy Commission.
[1] A. E. Taylor and E. Wood, Phil. Mag. 44, 95 (1953).
[2] Vaughn Culler and R. W. Waniek, Phys. Rev. **87**, 221 (1952).
[3] R. W. Waniek and Vaughn Culler, Phys. Rev. **95**, 659 (1954).
[4] Total cross sections of C and Fe far high-energy neutrons have also been obtained by B. Ragent, University of California Radiation Laboratory Report UCRL-2337, 1953 (unpublished).

Element 100 Produced by Means of Cyclotron-Accelerated Oxygen Ions

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(Received May 18, 1954)

THE beam of high-energy $(O^{16})^{6+}$ ions produced by the 225-cm cyclotron of this institute[1] has been used to bombard uranium targets. An alpha activity which is ascribed to an isotope of element 100 has been found among the transmutation products formed in this way.

Uranium metal was irradiated for several hours with the internal oxygen beam, at a radius of 85 cm. At this radius the maximum attainable energy of $(O^{16})^{6+}$ ions is roughly 180 Mev. Measurements were made of the intensity of oxygen ions reaching this radius with energies greater than 60 Mev, the best beam being about 0.03 microampere. For the production of californium as a reference element the uranium target was irradiated