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Radiation Laboratory

Contract No. W-7405-Eng 48

PROTON ANGULAR DISTRIBUTION FOR 90 MEV NEUTRON-PROTON SCATTERING

James Hadley, Cecil E. Leith, and Herbert F. York

November 3, 1947

Berkeley, California

PROTON ANGULAR DISTRIBUTION FOR 90 MEV NEUTRON-PROTON SCATTERING

James Hadley, Cecil E. Leith, and Herbert F. York

Radiation Laboratory, Department of Physics
University of California
Berkeley, California

November 3, 1947

The angular distribution of the recoil protons in neutron -proton scattering at 90 Mev has been measured for angles between 5° and 65° from the direction of the neutron beam. The neutrons were produced by stripping 190 Mev deuterons in a 1/2 inch Be target in the 184" F.M. cyclotron. R. Serber [1]

(1) R. Serber, Phys. Rev., Dec. 1, 1947

has calculated the neutron energy distribution; it has a peak at 90 Mev and a half width of 27 Mev. This distribution has been checked experimentally for the neutrons by Wilson Powell [2] and by W. Chupp, E.Gardner, and T.B.Taylor[3]

(2) Wilson Powell, to be published

(3) W. Chupp, E. Gardner, and T. B. Taylor, to be published

for the protons also produced by stripping. The neutrons were collimated by a two-inch hole through 8 feet of concrete.

Thin paraffin scatters of known hydrogen and carbon content were used; the number of protons arising from neutron-carbon and neutron-air reactions was determined by using pure carbon scatters and by making blank runs. The scatters were placed in the beam outside of the concrete shielding at a point approximately 52 feet from the cyclotron target.

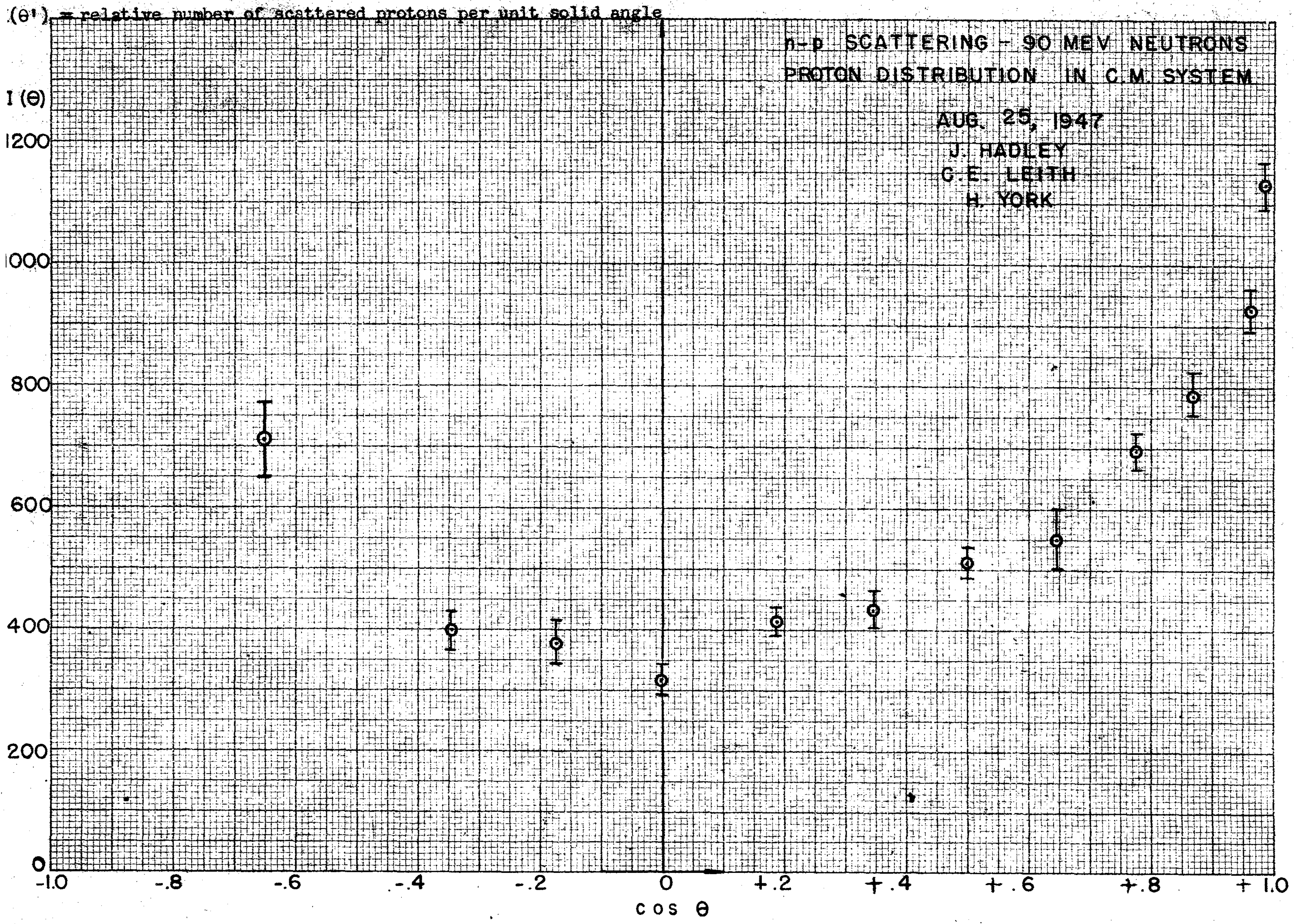
The scattered protons were detected by a telescope of four proportional counters used in coincidence, and set at a constant distance from the scatterer but at a varying angle from the neutron beam. A copper absorber was placed between the scatterer and the counters. The thickness of the absorber was adjusted for each angle so that only protons scattered by incident neutrons of energy greater than 66 Mev could be counted. It was found that the results did not depend on whether the absorber was placed in front of all four counters, or between the first two.

The beam was monitored by placing a second one inch piece of paraffin in the neutron beam and measuring the protons scattered from it by means of two additional proportional counters.

Fig. 1 is a plot of our results transposed into the center of mass system. Relative proton intensity per unit solid angle is plotted against cos θ, where θ is the scattering angle in this system. The proton peak in the forward direction is expected on the basis of exchange force theory. The apparent symmetry about 90° would indicate that there are equal amounts of exchange and non-exchange scattering. The experiments are limited at present to $\theta \leq 130^{\circ}$ because of the miniumum energy a proton must have in order to be detected by our counting system. The data shown are in agreement within statistical error with points determined from some 200 cloud chamber pictures of knock-on protons taken by Wilson Powell's group.

The errors indicated are twice the probably errors calculated on the basis of the counting statistics. The additional error is a somewhat arbitrary estimate of the possible size of systematic experimental errors. The possible sources of the latter are geometrical inaccuracies, changing coincidence efficiency with proton energy and counting rate, and effects due to stray neutrons. All of these errors would be functions of angle. Thus far, investigations of these factors has indicated that each is smaller than the statistical errors.

A detailed report of this work will be made later after more data have been taken, and the sources of experimental error more thoroughly investigated.


(θ') = relative number of scattered protons per unit solid angle
n-p SCATTERING - 90 MEV NEUTRONS
PROTON DISTRIBUTION IN C.M. SYSTEM
AUG. 25, 1947
J. HADLEY
C.E. LEITH
H. YORK
I (θ)
1200
1000
800
600
400
200
0
-1.0
-.8
-.6
-.4
-.2
0
+.2
+.4
+.6
+.8
+1.0
cos θ

The authors whish to thank Professor E. M. McMillan and Professor E. G. Segre, who guided these experiments, and Professor E. O. Lawrence, Dr. B. J. Moyer, and Professor Robert Serber for their suggestions and interest.

This paper is based on work done at the Radiation Laboratory of the University of California under contract No. W-7405-Eng-48 with the United States Atomic Energy Commission.

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