Title
POLARIZATION OF NEUTRONS PRODUCED BY BOMBARDING TARGETS WITH 285 MeV POLARIZED PROTONS

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Polarization of Neutrons Produced by Bombarding Targets with 285 Mev Polarized Protons

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July 12, 1954

Berkeley, California
Polarization of neutrons produced by bombarding targets with 285 MeV polarized protons

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Polarized neutrons have been produced by quasi-elastic scatter of polarized protons on the nucleons of carbon, beryllium, and lithium targets.

The polarized proton beam was obtained by scattering the cyclotron beam on an internal beryllium target, using the arrangement of Chamberlain et al. This resulting proton beam had a polarization of 65 ± 3 percent, a mean energy of 285 Mev, and a flux of approximately $10^5$ protons per second in the "cave" outside the cyclotron shielding.

When targets were bombarded by these polarized protons, neutrons (and protons) were ejected by nucleon-nucleon collisions. The neutrons were counted in 180° center-of-mass coincidence with their recoil protons, and only recoil protons of greater than $0.7 E_0 \cos^2 \theta$ energy were accepted. Thus only quasi-elastic proton-neutron events were recorded. One telescope subtended a solid angle of approximately 1/200 ster. but the other needed to subtend 1/10 ster. to give good counting rates for some of the data.

The telescopes used for recording proton-neutron events could also be used for recording proton-proton events.

Alignment of the apparatus was checked by measuring the asymmetry of double scattered protons as in the experiment of Chamberlain et al. Our data were found to agree within statistical errors with their results.

It can be shown\(^2\) that a left-right asymmetry in the counting rate of neutrons can be related to the polarization \(P_p\) of the incident proton beam and the polarization \(P_n\) of the neutrons by the usual equation

\[
e = \frac{(L-R)}{(L+R)} = \frac{P_p P_n}{P_n} ,
\]

where \(e\) is the asymmetry, and \(L\) and \(R\) are the neutron counting rates at equal scattering angles to the left and right. In the present experiment this gives \(P_n = e/0.65\).

Figures 1 and 2 give the quasi-elastic asymmetry, \(e\), for neutrons from carbon, beryllium, and lithium targets. For angles greater than 90° center-of-mass the neutrons were defined by the telescope with poor angular resolution.

It should be noted that the non-zero neutron polarization at 90° center-of-mass indicates\(^4\) the presence of both odd and even terms in the scattering analysis. A subsequent experiment by Chamberlain et al.\(^3\) using a liquid deuterium target gives results in good agreement with our data on carbon.

Figure 3 shows the asymmetry of quasi-elastic proton-proton scatters in carbon, obtained at the same time as the neutron data.

This work was done under the auspices of the Atomic Energy Commission.

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\(^2\) M. Ruderman, private communication.


\(^4\) Don R. Swanson, Phys. Rev. 84, 1086 (1951).
Asymmetry $e$ plotted as a function of the center-of-mass neutron angle for proton-neutron quasi-elastic scattering off carbon. The errors shown include only counting statistics.
Asymmetry 3 plotted as a function of the center of mass neutron angle for proton-neutron quasi-elastic scattering off lithium and beryllium. The errors shown include only counting statistics.
Fig. 3  Asymmetry $e$ plotted as a function of the center-of-mass proton angle for the proton-proton quasi-elastic scattering off carbon. The errors shown include only counting statistics.