NEUTRON POLARIZATION IN THE $C^{12}(d, n)N^{13}$ REACTION

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The polarization of neutrons from the reaction $C^{12}(d, n)N^{13}$ corresponding to the formation of the N^{13} nucleus in the ground state was measured for $E_d = 6.5$ MeV and a reaction angle $\theta_{1\,lab} = 40°$. The azimuthal asymmetry was measured in helium with a high-pressure scintillation gas counter. The polarization was found to be $P(40°) = (-25.0 \pm 3.0)\%$.

THE polarization of neutrons from the $C^{12}(d, n)N^{13}$ reaction corresponding to the production of the N^{13} nucleus in the ground state have previously been measured for deuteron energies of 2.5—3.6 MeV,[1] and at a deuteron energy $E_d = 11.8$ MeV.[2] If we take, in accordance with the decision of the Basel conference, the positive direction of the polarization vector to be the direction of the vector $\mathbf{n} = \mathbf{k}_d \times \mathbf{k}_n / |\mathbf{k}_d \times \mathbf{k}_n|$, where $\mathbf{k}_d$ and $\mathbf{k}_n$ are the wave vectors of the deuteron and neutron, then for the measured energies the polarization turns out to be negative. For $E_d \approx 3$ MeV the polarization attains a flat maximum, reaching about 30% at a c.m.s. angle of $\theta_1 = 20°$.[1] For $E_d = 11.8$ MeV the maximum value of the polarization is 36.4% at $\theta_1 = 50°$ in the laboratory system. In the present work we have measured the polarization of the neutrons at a deuteron energy of 6.5 MeV and a l.s. angle $\theta_1 = 40°$.

A schematic drawing of the experimental setup is shown in Fig. 1. The 6.5-MeV deuteron beam from the cyclotron was focused by means of quadrupole lenses at the center of the aquadag target, whose thickness corresponded to a deuteron energy loss of 600 keV. The target area irradiated by the beam amounted to 18 mm^2, the average current on the target was 5 microamp. The neutrons from the $C^{12}(d, n)N^{13}$ reaction were accepted at an angle $\theta_{1\,lab} = 40°$ by a conic paraffin collimator with an angular opening of 3°. A high-pressure scintillation counter was employed as an analyzer. The counter consisted of a cylindrical chamber with a diameter of 4 and height of 7 cm, and the total pressure of the gas mixture (He + 7% Xe) was 70 atm. The counter could be operated for several months without refilling.

The neutrons, scattered by the helium at an angle of $\theta_{2\,lab} = 123°$ were registered by two stilbene crystals. In all three detectors we employed high-gain FÉU-13 photomultipliers. All three detectors were mounted on a turning device, which made it possible to turn them 360° with respect to the gas counter.

The block diagram of the electronic equipment is shown in Fig. 2. The fast-coincidence technique was used to reduce the background due to gamma radiation and scattered neutrons. The pulses from each neutron detector 1 and 3 were selected for coincidence with the pulses of the gas counter 2 by a two-channel fast-coincidence circuit 4 with a time resolution of 5 nanosec. The pulses from the fast-coincidence circuit were fed to the first and third input of the slow-coincidence circuit 6 which had a time resolution of 2 microsec. Pulses from the last dynode of the photomultiplier analyzer were fed to the second input of the slow-coincidence circuit through the differential discriminator 5. The discriminator selected that part of the spectrum of the recoil nuclei which corresponded to neutrons connected with the pro-

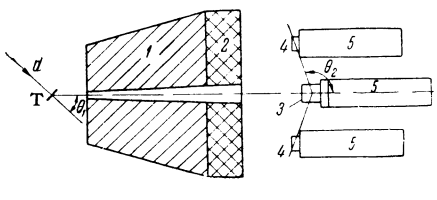

FIG. 1. A schematic diagram of the setup for investigating the polarization: T – target, 1 – paraffin cone, 2 – lead shield, 3 – scintillation gas counter, 4 – crystal neutron detectors, 5 – photomultipliers.

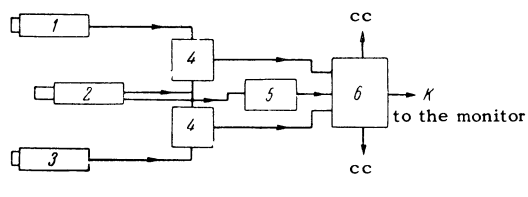

FIG. 2. Block circuit of the electronics: 1, 3 – crystal neutron detectors, 2 – scintillation gas counter, 4 – two-channel fast-coincidence circuit, 5 – differential discriminator, 6 – slow-coincidence circuit, cc – counting circuits.

duction of the N^{13} nucleus in the ground state and scattered in the direction of the neutron detectors. The output of the differential discriminator was also used for monitoring.

Much attention was accorded in the experiment to the correct adjustment of the instrument. To this end a special adjusting device with high mechanical precision was constructed. A detailed description of the neutron polarimeter and its operation will be published.

In order to be completely certain that there is no instrument asymmetry, we measured the "up-down" asymmetry before each set of "left-right" asymmetry measurements. The background was obtained by introducing a 30-nanosec delay into the central channel of the fast-coincidence circuit, and amounted on the average to 20% of the total count of fast-slow coincidences.

Corrections for the geometry were made by the method of Meier et al.[3] The asymmetry averaged over all measurements with allowance for the geometrical corrections is

$$\varepsilon_{av} = (23.0 \pm 3.0)\%.$$

Using the value of the polarization of neutrons on helium at $E_n = 5.7$ MeV and $\theta_{2\,lab} = 123°$ equal to [4] $P_{He^4} = 0.94$, we obtain for the neutron polarization from the $C^{12}(d, n)N^{13}$ reaction for $E_d = (6.2 \pm 0.3)$ MeV a value of $P(40°) = (-25.0 \pm 3.0)\%$.

Thus, the sign of the polarization is in agreement with that expected from the theory of polarization in stripping reactions in the given energy interval.

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