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

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The azimuthal asymmetry of neutrons from the reaction C^{12} (d, n) N^{13} scattered on helium was measured. The measurements were carried out on the neutron group corresponding to the formation of N^{13} in the ground state. The deuteron energy was 11.8 ± 0.8 Mev. The polarization values of neutrons emitted at various angles from the carbon target are calculated with the Seagrave phase shifts for the scattering of neutrons on He^4.

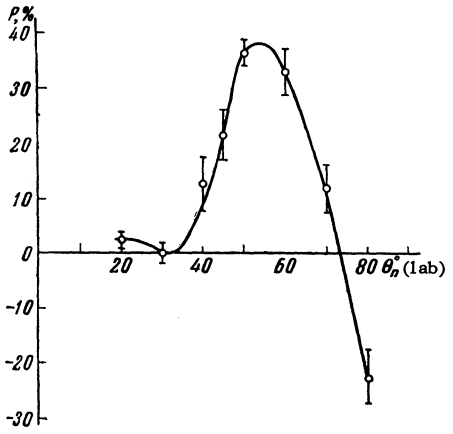
WITH the aid of a helium analyzer, described earlier in detail in reference 1, we measured the azimuthal asymmetry in the scattering of neutrons from the reaction C^{12} (d, n) N^{13}. The measurements were carried out on the neutron group corresponding to the formation of N^{13} in the ground state.

A 12.3-Mev deuteron beam from the cyclotron at the Institute of Theoretical and Experimental Physics, Academy of Sciences, U.S.S.R. was focused by a system of magnetic quadrupole lenses onto a graphite target obtained by depositing an ammonia solution of aquadag on a gold base. The thickness of the graphite layer corresponded to the range of 1.6-Mev deuterons; the beam cross section at the target was 3 × 5 mm; the average beam current was 1.5 μa. The proportional helium counters of the analyzer operated under a pressure of 6.26 atm. The pressure was maintained constant to an accuracy of ± 0.5 mm Hg. A stream of commercial helium (99.8%) flowed continuously through the counters at a rate of 40 cc/sec.

The helium analyzer consisted of a battery of three counters (7 mm diam and 66 mm long) lying in a plane perpendicular to the rocking plane (plane of the reaction). The distance from the target to the rocking axis was 150 mm. The rocking axis passed through the center of the effective volume of the counters, whose length varied with the angle of emission of the neutrons in the limits of 15 — 25 mm. For a counter rocking angle of ± 19°, the size of the angle within which the neutrons from the target entered the effective volume of the counters was 3°, and the angular spread of the helium recoil nuclei recorded by the analyzer did not exceed 10°. Therefore, the correction to the observed asymmetry due to the anisotropy in the distribution of neutrons from the reaction was small (~ 2 — 3%), and instead of integrating over the effective volume in the calculation of the polarization of the analyzer, it was possible to limit the calculation to one point at the center of rocking. Hence the parameters of the arrangement ensured (in contrast to the experiment of reference 1) that the measurements were made under conditions of "good geometry."

The recorded helium recoil nuclei corresponded to neutrons of energy $\gtrsim 0.8\ E_{max}$ (E_{max} is the maximum energy for a given angle of observation). In this interval, there were no neutrons associated with the production of N^{13} in the excited state. We thus actually measured the asymmetry for the group of neutrons corresponding to the formation of N^{13} in the ground state in a deuteron energy interval determined by the target thickness (~ 1.6 Mev). The background of spurious pulses in the analyzer channel from neutrons produced in the base, diaphragms, etc. did not exceed 10 — 15% and was eliminated by special measurements.

The counters were calibrated in the same way as in reference 1, i.e., on neutrons from the reaction under study emitted at an angle $\theta_n = 60°$. We obtained the following values for the ratio R



of counts at a rocking angle $\varphi_\alpha = +19°$ to counts at a rocking angle $\varphi_\alpha = -19°$ for various angles of emission of neutrons from the carbon target (only the statistical errors of measurement are shown):

θ_n (lab), deg	10	30	40	45	50	60	70	80
R	1.05±0.03	1.00±0.03	1.21±0.11	1.45±0.12	1.94±0.08	1.79±0.13	1.23±0.09	0.66±0.06

The calculation of the polarization of the reaction from the asymmetry data was carried out by means of Seagrave phase shifts for the scattering of neutrons on He^4 (see reference 2). The values obtained for the neutron polarization are given in the table and in the figure (for $E_d = 11.8 \pm 0.8$ Mev). The positive value of the polarization was taken in the direction $\mathbf{n} = \mathbf{k}_n \times \mathbf{k}_d$.

θ_n (lab), deg	20	30	40	45	50	60	70	80
E_n (lab), Mev	11.4	11.2	10.9	10.8	10,6	10,3	9.92	9,54
P_n, %	2.6±1.5	0±1.7	12.8±5.2	21.6+4.6	36.4+2.1	33.1±3.9	11.7±4.2	−22.6±4.9

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