NEUTRON POLARIZATION IN $B^{11}(d, n)C^{12}$, C^{12*} REACTIONS

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WE measured the polarization $P_n(\theta_n)$ of the neutrons in the reaction $B^{11}(d, n)C^{12}$ for the ground and first-excited levels of C^{12} (Figs. 1 and 2).

The polarization measurements were made with the extracted beam of the cyclotron of the Institute of Theoretical and Experimental Physics, with deuteron energy $E_d = 12.3 \pm 0.3$ MeV; the beam divergence angle in the reaction plane was $\sim 0.5°$, and the target area subtended by the beam was 3×5 mm, with the average current ~ 2.5 μA.

The target was made of boron of natural isotopic composition; the target thickness was ~ 20 mg/cm^2 (~ 1.8 MeV). The boron was pressed in a thin homogeneous layer on a substrate of tantalum and covered with platinum foil (103 mg/cm^2). The average deuteron energy in the reaction was 9.3 ± 1.2 MeV.

The polarization of the reaction neutrons was determined from the azimuthal asymmetry of the scattering by He^4. The polarimeter consisted of a group of directional helium-filled proportional counters[1]. The polarimeter was set to the investigated neutron-spectrum interval by selecting the helium pressure in the counter[2]. The angle of rotation of the analyzer counters during the measurement of the azimuthal scattering asymmetry was $\varphi_\alpha = 20-28°$ ($2\varphi_\alpha = 180° - \vartheta_\alpha$, where ϑ_α — angle of scattering of neutrons by He^4 nuclei in the center of mass system). The polarimeter was calibrated by α particles from Pu^{239}. The collimated α source was installed in the end window of a proportional counter. The amplitude resolution of the polarimeter counter was $\sim 6\%$. The measurements were monitored by integrating the current to the target.

The polarization produced upon scattering of the neutrons by He^4[3] was averaged over the α-particle recoil angles φ_α ($\pm \Delta\varphi_\alpha = 4-6°$).

In determining the polarization of the neutrons in the reactions $B^{12}(d, n)C^{12}$, C^{12*} account was taken of corrections for the anisotropy of the angular distribution of the neutrons[4]; the values of the corrections did not exceed 6%. Only statistical errors are indicated everywhere.

The background in the working channels of the analyzer did not exceed 15%. The positive normal direction is $n = k_d \times k_n$.
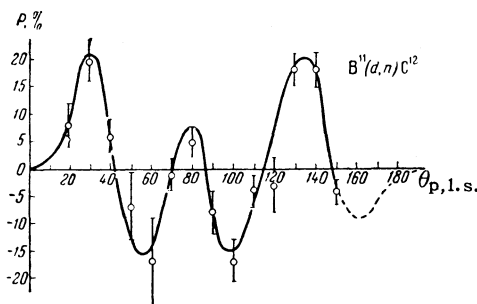

FIG. 1. Polarization of neutrons in $B^{11}(d, n)C^{12}$, corresponding to the ground state of the C^{12} nucleus.

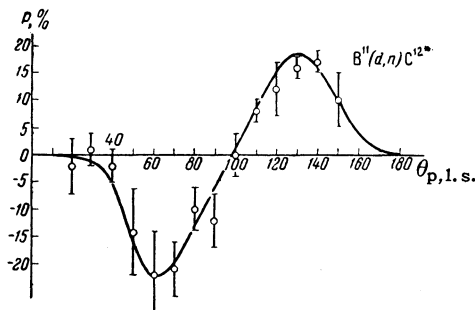FIG. 2. Polarization of neutrons in the reaction $B^{11}(d, n)C^{12}*$, corresponding to the first excited level of C^{12}.

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