Proton polarization in the reaction $\gamma d \rightarrow np$ at c.m. angles of 90° and 120° at γ energies in the range 650–1000 MeV

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The polarization of the protons in the reaction $\gamma d \rightarrow np$ has been measured over the γ energy range 650–1000 MeV. The polarization is large over this entire range.

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Measurements of the polarization of the protons produced in the photodisintegration of the deuteron at γ energies in the range 350–700 MeV (Refs. 1–3) have revealed a resonance structure in the energy dependence of the polarization with an anomalously high value (~80%) which cannot be described by the existing theory.[4,5] Analysis of these data led to the suggestion that there were resonances with a baryon number of 2 in an intermediate state of the channel for the reaction $\gamma d \rightarrow np$. This model requires a detailed analysis and further experimental study of the photodisintegration of the deuteron over a broad range of the proton emission angle and over a broad range of γ energies.

In this letter we are reporting data on the polarization of protons in the reaction

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TABLE I.

E_γ^{eff}, MeV	$P \pm \Delta P$
600	-0.35 ± 0.07
650	-0.43 ± 0.085
700	-0.58 ± 0.12
750	-0.72 ± 0.27

$\gamma d \to np$ at a c.m. angle of 90° over the γ energy range 650–800 MeV and at a c.m. angle of 120° in the γ energy range 650–1000 MeV. For these measurements we used the electron-bremsstrahlung beam of the 2-GeV Khar'kov linear accelerator. The bremsstrahlung beam passed through a liquid-deuterium target 60 mm in diameter and 200 mm long. The number of protons emitted from the empty target did not exceed 5% of the number emitted from the target when filled with the liquid deuterium. Secondary protons were momentum-analyzed with a magnetic spectrometer[6] and detected with a telescope of optical spark chamber.[7] The spectrometer monitored an angle of ±1.2°. The energy resolution, ±25 MeV, was set by this angle and by the momentum interval of the protons detected by the telescope for the given photon energy. The measurements were carried out in a γ energy interval no more than 120 MeV from the end of the bremsstrahlung spectrum.

The proton polarization was calculated by the maximum-likelihood method. The false asymmetry was determined for each measured energy from the "up–down scattering" and found to be less than 10%.

The measured polarizations of the protons in the reaction $\gamma d \to pn$ at c.m. angles of 90° and 120° are listed in Tables I and II, respectively, and also plotted in Figs. 1 and 2, respectively. These results reveal an increase in the proton polarization with

TABLE II.

E_γ^{eff}, MeV	$P \pm \Delta P$	E_γ^{eff}, MeV	$P \pm \Delta P$
625	-0.51 ± 0.1	875	-0.63 ± 0.12
675	-0.67 ± 0.08	925	-0.87 ± 0.16
725	-0.54 ± 0.07	975	-0.85 ± 0.20
775	-0.56 ± 0.08	1025	-0.96 ± 0.35
825	-0.37 ± 0.12	—	—

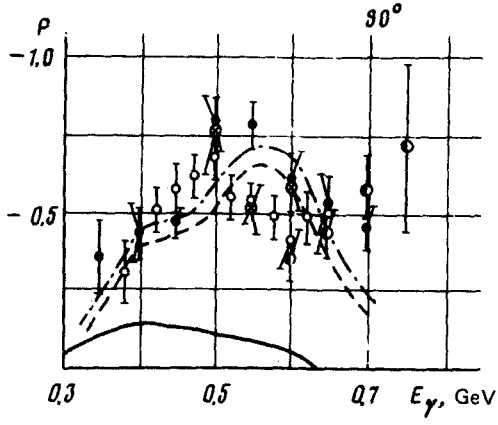

FIG. 1. Energy dependence of the polarization of the protons in the reaction $\gamma d \to pn$ for the proton emission angle $\theta_p = 90°$ (c.m.). –Results of Ref. 2; –results of Ref. 1; –results of Ref. 3; –results of the present study. The indicated measurement errors are statistical.

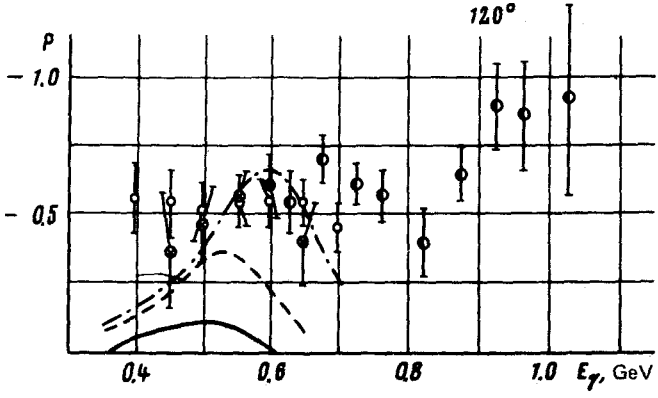

FIG. 2. Energy dependence of the polarization of the protons in the reaction $\gamma d \to np$ for the c.m. angle $\theta_p = 120°$. The symbols have the same meaning as in Fig. 1.

increasing γ energy. The curves are calculated from the model of Ref. 8; possible dibaryon resonances with masses of 2260 and 2380 MeV are taken into account. These curves show a tendency toward a decrease at an energy of only 650 MeV, in contradiction of these new experimental data.

A new multipole analysis must be carried out with the present data on the proton polarization and also the new data on the Σ and T asymmetry[9] and on the cross sections at an angle of 180°.

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