Proton polarization in the photodisintegration of the deuteron at γ energies in the range 700–1100 MeV

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The polarization of protons in the reaction $\gamma + d \rightarrow p + n$ has been measured for γ energies over the range 700–1100 MeV. The protons are observed to have a large polarization over this entire γ energy range.

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Kamae *et al.*[1] and Ikeda *et al.*[2] first observed an anomalous polarization behavior in measurements of the polarization of protons from the reaction $\gamma + d \rightarrow p + n$ over the γ energy range 350–650 MeV. They attributed this anomalous behavior to dibaryon resonances. A search for dibaryon resonances is of fundamental importance for research on hadron structure, since the existence of such resonances has been predicted by various quark bag models.

In Ref. 3 we measured the polarization over the same γ energy range as in Ref. 1, but with twice as good an energy resolution and with a smaller statistical error. Within the experimental errors, the results of Refs. 2 and 3 agree well.

In this letter we report measurements of the proton polarization in the reaction $\gamma + d \rightarrow p + n$ at $E_\gamma = 750$–900 MeV for angles $\theta_p = 90°$ c.m. and for $E_\gamma = 700$–1100 MeV for $\theta_p = 120°$ c.m. Preliminary data on the measurements of the proton polarization at these angles and at these γ energies have been published previously.[4]

The experiments were carried out in the electron bremsstrahlung beam at the 2-GeV Khar'kov Linear Accelerator. A γ beam with a cross-sectional area of 12×12 mm^2 is produced in a liquid-deuterium target 60 mm in diameter and 200 mm long.

TABLE I.

$\theta_p^* = 90°$			$\theta_p^* = 120°$		
E_γ^{eff}, MeV	$P \pm \Delta P$	E_γ^{eff}, MeV	$P \pm \Delta P$	E_γ^{eff}, MeV	$P \pm \Delta P$
750	-0.62 ± 0.16	725	-0.46 ± 0.06	975	-0.69 ± 0.13
800	-0.86 ± 0.11	775	-0.55 ± 0.07	1025	-0.85 ± 0.19
850	-0.70 ± 0.12	825	-0.37 ± 0.09	1075	-0.93 ± 0.24
900	-0.93 ± 0.3	925	-0.65 ± 0.12	1125	-0.57 ± 0.3

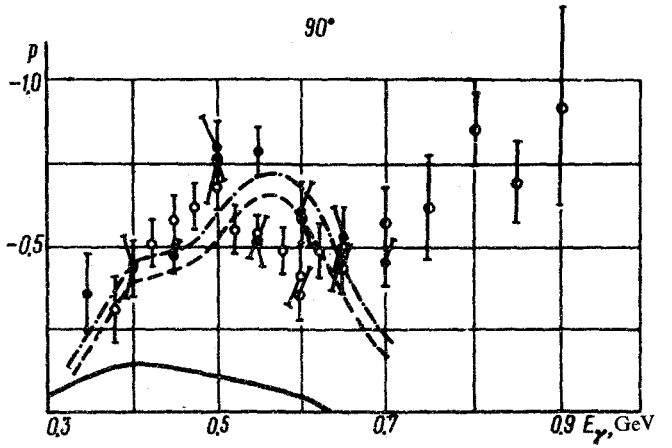

FIG. 1. Energy dependence of the polarization of the protons in the reaction $\gamma + d \to p + n$ for the angle $\theta_p = 90°$ c.m. ●—Reference 1; ○—Ref. 2;○—Ref. 3; ○—present results.

The secondary protons are momentum-analyzed by a magnetic spectrometer and detected by a telescope of optical spark chambers.[5] The protons are identified on the basis of the momentum determined by the magnetic spectrometer and by their range in a spark chamber with graphite electrodes, used to detect p-C scattering events. The contribution of the empty target was less than 5%; the energy resolution of the experiment was ± 25 MeV. The maximum energy of the γ spectrum was chosen to eliminate the possibility that protons from other reaction channels might be detected. The proton polarization was calculated by the maximum likelihood method.

Table I and Figs. 1 and 2, respectively, show the measured proton polarization in the reaction $\gamma + d \to p + n$ for the angles 90° and 120° c.m. Also shown here are the results of some earlier measurements.[1,2] It should be noted that the energy dependence of the polarization for the angles $\theta_p = 90°$ and $\theta_p = 120°$ c.m. does not reveal the clearly defined resonance behavior mentioned in Ref. 1. The polarization is large over the entire γ energy range studied. The behavior of the polarization calculated on the

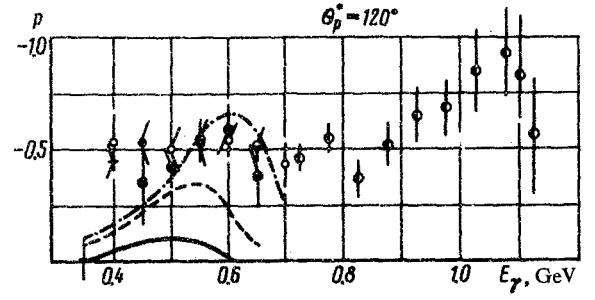

FIG. 2. Energy dependence of the polarization of the protons in the reaction $\gamma + d \to p + n$ for the angle $\theta_p = 120°$ c.m. The notation is the same as in Fig. 1. Solid curve—calculation ignoring dibaryon resonances; dashed curve—calculation incorporation $1(3^-)$ and $0(3^+)$ resonances; dot-dashed curve—calculation incorporation $1(3^-)$ and $0(1^+)$ resonances.

basis of dibaryon resonances with quantum numbers $1(J^P) = 1(3^-)$, $0(1^+)$, and $0(3^+)$ (Ref. 6) is not consistent with the experimental data in the energy range studied.

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