Letters to the Editor

*TRANSVERSE POLARIZATION OF Λ HYPERONS, GENERATED BY 2.8-Bev/c PIONS ON XENON NUCLEI**

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THE question of the magnitude and sign of the polarization of Λ hyperons generated in different reactions at different interacting-particle energies, was first studied in detail in an investigation of the reaction $\pi + p \rightarrow \Lambda + K^0$ in connection with a verification of the conservation of space parity in neutrinoless decays, a particular case of which is the decay $\Lambda \rightarrow p + \pi^-$.[2-4]

It was shown in references 3 — 4, where negative pions of energy ~ 1 Bev were used, that space parity is not conserved in the decay of Λ particles and that the Λ hyperons are polarized along the direction $\mathbf{p}_{inc} \times \mathbf{p}_\Lambda$ ($\mathbf{p}_{inc}$ is the momentum of the incident pion, $\mathbf{p}_\Lambda$ is the momentum of the Λ hyperon).

The angular distribution of the decay pions is proportional to $(1 + \alpha\overline{P}\cos\beta)$, where $\overline{P}$ is the polarization averaged over the creation angles, α a coefficient characterizing the degree of parity nonconservation, and β the angle between the momentum of the decay pion and the vector $\mathbf{p}_{inc} \times \mathbf{p}_\Lambda$ (in the rest frame of the Λ hyperon).

The results of the measurements of $\alpha\overline{P}$ were summarized by Glaser:[5]

Berkeley (hydrogen bubble chamber):	$\alpha\overline{P} = 0.73 \pm 0.14$
Princeton (multi-plate cloud chamber):	No asymmetry, but statistics scanty
Michigan (xenon bubble chamber):	$\alpha\overline{P} = 0.45 \pm 0.15$

The energy of the incident pions in all the investigations cited by Glaser is close to 1 Bev. It can be seen that at these energies $\alpha\overline{P}$ differs from zero and is positive.

An investigation of the "up-down" asymmetry in the distribution of the decay pions relative to the plane of Λ creation at other values of incident-pion energies and on other nuclei is of interest both from the point of view of determining the value of $\alpha\overline{P}$ and the sign of polarization of the Λ hyperons generated in various processes, and from the purely methodological point of view — for finding possible sources of polarized Λ particles.

We have measured the "up-down" asymmetry in the decay of Λ hyperons generated by negative pions with momentum (2.8 ± 0.3) Bev/c in a xenon bubble chamber[6] in the reaction

$$\pi^- + Xe \rightarrow \Lambda + K + Xe' + n\pi.$$

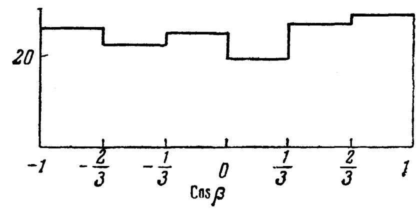
The average multiplicity of the charged pions accompanying the Λ particles is, according to preliminary estimates, $n \approx 1.2$.

The identification of the Λ particles and the determination of the momenta of the decay negative pion and proton were based on the magnitude of the angle of divergence of the π^- and p relative to the direction of $\mathbf{p}_\Lambda$, and also on the measured values of the ranges and ionizing abilities of these particles.

The figure shows the distribution of the decay pion relative to $\cos\beta$ (75 up and 73 down). As can be seen from the plot, there is practically no asymmetry. The coefficient $\alpha\overline{P}$, calculated from the average cosine, is found to be

$$\alpha\overline{P} = 3\Sigma\cos\beta_i/N \pm (3/N)^{1/2} = 0{,}08 \pm 0{,}14.$$

Thus, the Λ hyperons generated by 2.8-Bev/c negative pions on xenon nuclei do not have a polarization component in the direction $\mathbf{p}_{inc} \times \mathbf{p}_\Lambda$, inasmuch as[7,8] $\alpha \neq 0$. Consequently, the heavy nuclei cannot be used as targets for the production of Λ particles polarized in the direction $\mathbf{p}_{inc} \times \mathbf{p}_\Lambda$ when the momentum of the incident pions is ~ 3 Bev/c.



We are continuing to accumulate material in order to improve the statistical accuracy.

*A preliminary report was published in the Proceedings of the Rochester Conference of 1960.[1]

[1] Proc. of the 1960 Ann. Conf. on High-Energy Physics, Rochester, 1960, p. 382.

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[3] Crawford, Cresty, Good, Gottstein, Lyman,

Solmitz, Stevenson, and Ticho, Phys. Rev. **108**, 1102 (1957).

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[5] D. A. Glaser, Paper delivered at Kiev Conference on High-Energy Physics, 1959.

[6] E. V. Kuznetsov and I. Ya. Timoshin, Приборы и техника эксперимента (Instrum. and Exptl. Techniques), No. 4, 40 (1959).

[7] Boldt, Bridge, Caldwell, and Pall, Phys. Rev. Lett. **1**, 256 (1958).

[8] R. W. Birge and W. B. Fowler, Phys. Rev. Lett. **5**, 254 (1960).

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CIRCULAR POLARIZATION OF GAMMA QUANTA IN THE REACTION $B^{10}(d, p\gamma)B^{11}$

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ZIMANYI has shown in an earlier paper[1] that a reaction that yields polarized products causes the final nucleus to become excited so as to emit a circularly-polarized γ quantum after emission of the nucleon, if the quantum is registered simultaneously with the nucleon. This circular polarization is connected with the polarization of the final nucleus by the known relations of multipole radiation, so that by determining the degree of polarization of the γ quanta we determine the polarization vector of the final nucleus. Satchler[2] and Zimanyi[3] have established recently that measurement of the circular polarization of the γ quanta may be particularly important in the investigation of stripping reactions, since it can yield information on the noncentral part of the interaction.

We have carried out experiments on the determination of the circular polarization of 2.14-Mev γ quanta from the first excited state of B^{11} in the reaction $B^{10}(d, p\gamma)B^{11}$. A thick layer of boron enriched with B^{10} to 90 percent was bombarded with 420-kev deuterons. The stripping mechanism plays an important part even at so low an energy.[4]

The experimental setup is shown in Fig. 1. We detected the protons and γ quanta emitted at 90° to the deuteron beam; the azimuthal angle between the two detectors was also 90°. We used the usual slow and fast coincidence system with resolution $\tau = 2.3 \times 10^{-9}$ sec. The slow part of the circuit consisted of two single-channel pulse-height analyzers to detect the 7.1-Mev protons and 2.14-Mev γ quanta. The polarization analyzer used was a core 8 cm long, made of Armco iron.

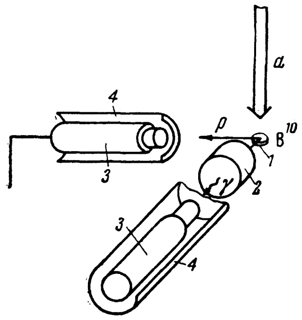

FIG. 1. Diagram of experimental setup: 1 – target, 2 – analyzer, 3 – photomultiplier, 4 – shield.

If we denote by N^+ and N^- the number of γ quanta detected after passage through an analyzer magnetized parallel and antiparallel to the direction of propagation of the γ quanta, then the polarization is

$$P_\gamma = A(N^+ - N^-)/(N^+ + N^-).$$

The constant A depends on the energy of the γ quanta and on the geometry of the analyzer. In our case A = 32.

To prevent the stray field of the magnet from producing an asymmetry that may affect the photomultiplier, we used a permalloy shield and carried out two series of measurements, the geometry of which is shown in Fig. 2. If the magnetic field has axial symmetry, the asymmetry of the setup for cases 2a and 2b will be the same, but the sign of the polarization will be reversed. The effect of instability of the electronic apparatus was eliminated by changing the magnetization direction every 200 sec.

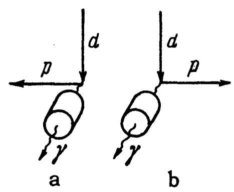

FIG. 2. Paths of deuterons, protons, and γ rays for the two measurements.

The results obtained so far are tentative, since only some 40 000 coincidences were counted. The polarization was found to be $P_\gamma = 37 \pm 19$ percent with the sign of $\mathbf{n} = \mathbf{k}_d \times \mathbf{k}_p$ chosen positive, in ac-