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Publication Date

1959-07-22

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UNIVERSITY OF CALIFORNIA
Lawrence Radiation Laboratory
Berkeley, California
Contract No. W-7405-eng-48

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Several experiments have indicated a possible forward-backward asymmetry in the decay of Λ^0 hyperon.¹ The effect was such that, in the Λ^0 rest frame, the decay pion preferred forward emission with respect to the Λ^0 line of flight. In view of the known decay asymmetry of the Λ^0 with respect to its direction of polarization,² the above asymmetry would imply a nonzero longitudinal component of polarization of the Λ^0 , which immediately suggests nonconservation of parity in the production interaction, assuming that parity doublets of the Λ^0 do not exist.³

A recent exposure of the Lawrence Radiation Laboratory 30-inch propane bubble chamber⁴ to a 1.15-Bev/c separated K^- beam⁵ offers the opportunity to explore the question further. Several thousand K^- interactions were photographed. This paper reports the initial results from a sample of 141 Λ^0 decays.

No separation is made here between production from hydrogen and from carbon. The sample includes both direct Λ^0 production and production that may result from secondary interactions such as $\Sigma + N \rightarrow \Lambda^0 + N$ conversion in carbon or from $\Sigma \rightarrow \Lambda^0 + \gamma$ decay. The hyperons are subject to possible

scattering within carbon nuclei; therefore lack of an observed polarization does not guarantee lack of polarization from the initial production. (These conditions are found in most of the experiments referred to above.)

The beam consisted of ~25% kaons and ~75% muons, with $\sim 0.15\pi^-$ per K^- , and was collimated so as to traverse only the thin window before entering the propane. This π^- flux should have produced in the sample used for this experiment only one or two hyperons of all kinds. Thus the Λ^0 -producing interactions in the chamber were predominantly those of beam K^- mesons. Each K^- star could be readily observed in scanning and an exhaustive search could be made for a V^0 decay.

No selection criterion was applied except that a few V^0 's originating in the window were rejected. The number of neutral-induced background stars was completely negligible. The possible bias that might result from failure to observe V^0 's with one very short track has been considered. The fraction of Λ^0 decays yielding a proton ≤ 3 mm in length, assuming the decay to be isotropic in the Λ^0 rest frame, is zero for Λ^0 momenta ≥ 350 Mev/c and increases rapidly for lower momenta. However, since so much of the Λ^0 momentum spectrum lies beyond 350 Mev/c, the bias is only ~6% in favor of forward protons. Similarly the fraction of Λ^0 decays with pions less than 3 mm in length is a maximum of ~5% at 600 Mev/c and over the observed spectrum yields a 2% bias against forward protons. Thus a net bias of only a few percent might exist if ranges less than 3 mm were unobservable. No corrections were made.

One-hundred-forty-one V^0 's were observed and identified as follows: $110\Lambda^0$; $19\theta^0$; $10\Lambda^0$ or θ^0 , consistent with either; 2 of poor quality, unidentifiable. Thus the distortion of the sample resulting from uncertain identifications is small. The identification was aided by the relatively low momenta of the Λ^0 's (Fig. 1), yielding, in general, decay protons with ionization considerably above minimum. Observation of the parent star in each case fixed the V^0 line of flight, resulting in an overdetermination of the V^0 decay kinematics.

The decay of the Λ^0 's results in a distribution of decay products in the Λ^0 rest frame of the form $(1 + a\bar{P}_3 \cos \theta)$, where θ is the angle between the decay pion and the Λ^0 direction of motion, \bar{P}_3 is the average component of polarization of the Λ^0 in this same direction, and a is the decay-asymmetry parameter for complete polarization of the Λ^0 . Figure 2 shows the observed distribution in $\cos \theta$ for $110\Lambda^0$ decays. Also shown (shaded) are the 10 events that were consistent with either Λ^0 or θ^0 . A χ^2 test of the assumption $a\bar{P}_3 = 0$ yields $\chi^2 = 7.1$ (five degrees of freedom). Probability of $\chi^2 > 7.1 = 0.25$. That is, the data are quite consistent with zero longitudinal polarization of the Λ^0 .

A measure of $a\bar{P}_3$ obtained from

$$a\bar{P}_3 = \frac{3}{N} \sum_{i=1}^N \cos \theta_i \pm \sqrt{\frac{3 - (a\bar{P}_3)^2}{N}}$$

yields $a\bar{P}_3 = -0.090 \pm 0.17$ for the $110\Lambda^0$ events, and -0.24 ± 0.16 with the inclusion of the $10\Lambda^0$ or θ^0 events. A subset consisting of 65 events satisfying $300 \text{ Mev/c} \leq p_{\Lambda^0} \leq 700 \text{ Mev/c}$ yields $a\bar{P}_3 = -0.06 \pm 0.21$. For these 65 events, the ionization of the decay proton is always greater than twice minimum, and the range of the proton is $\bar{r} > 3 \text{ mm}$.

The likelihood ratio, \mathcal{R} , for comparing the relative likelihood of any choice of $a\bar{P}_3$ to the choice $a\bar{P}_3 = 0$ is given by $\mathcal{R} = \prod_{i=1}^N (1 + a\bar{P}_3 \cos \theta_i)$. This function is plotted in Fig. 3 for the 110 Λ^0 's. These data, although consistent with $a\bar{P}_3 = 0$, are clearly not sufficient to rule out small values of $|a\bar{P}_3|$. To obtain a value of \mathcal{R} equal to 0.01 for the choice $a\bar{P}_3 = \pm 0.2$, for example, assuming the true value were zero, would require on the average ~350 events. Similarly, to rule out $a\bar{P}_3 = \pm 0.1$ at the same level would require ~1000 events. These numbers of events are available for future analysis.

This exposure was performed in collaboration with the Lawrence Radiation Laboratory hydrogen bubble chamber group, who established and maintained the separated K^- beam. We wish to thank Dr. Edward J. Lofgren and the Bevatron staff for their excellent cooperation and Larry O. Oswald and the bubble chamber crew for operation of the chamber.

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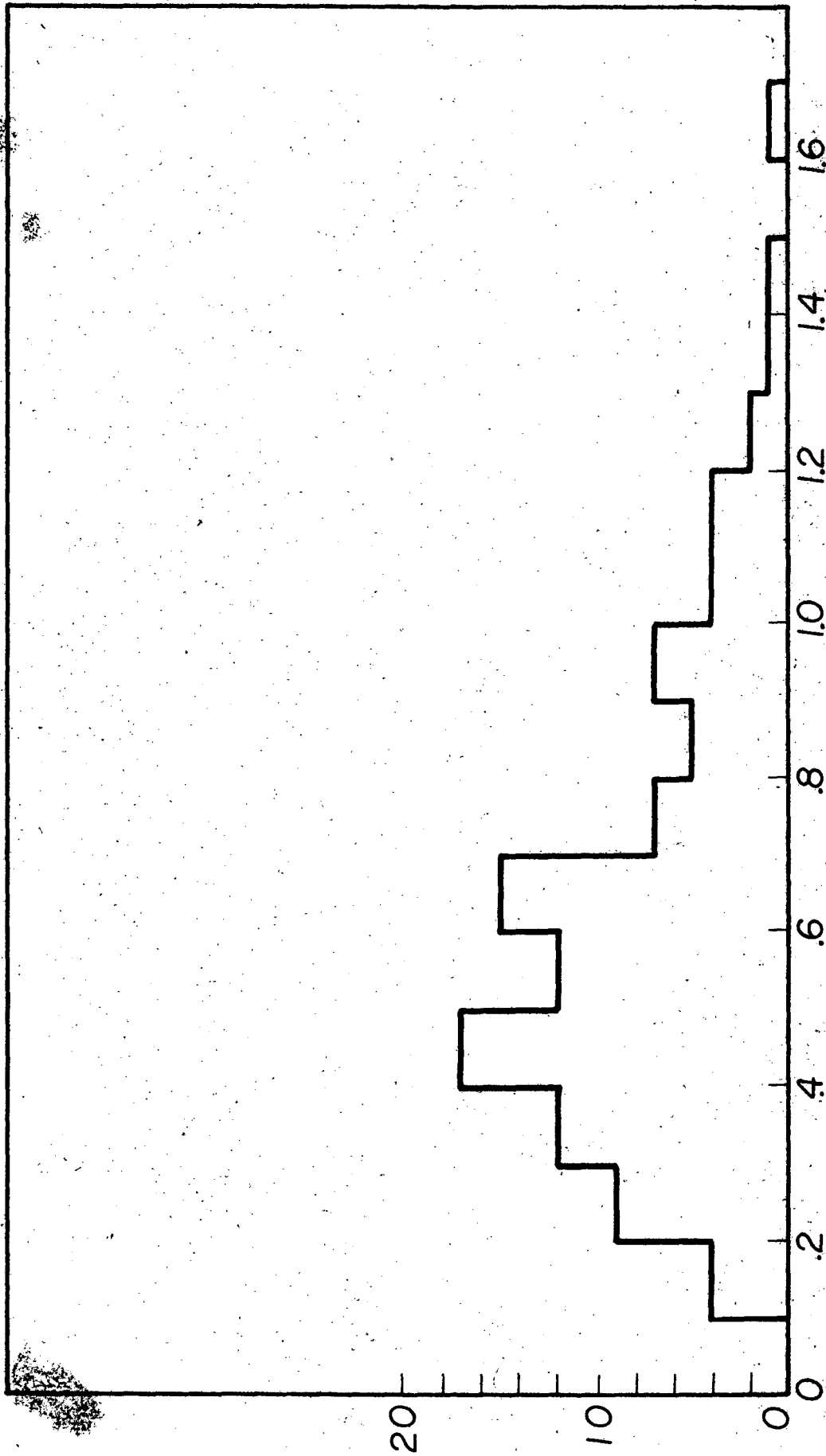
FIGURE LEGENDS

Fig. 1. Λ^0 momentum distribution.

Fig. 2. Angular distribution of decay pions from 110 Λ^0 decays. θ_{π}^* is the angle in the Λ^0 rest frame between π direction and direction of motion of Λ^0 . Ten events consistent with Λ^0 or θ_1^0 are shown shaded. The numbers of events within each interval are shown. The numbers of Λ^0/θ_1^0 events are in parentheses.

Fig. 3. Plot of likelihood ratio, \mathcal{R} , vs $\alpha\mathcal{F}_3$. \mathcal{R} is a measure of the relative likelihood for any value of $\alpha\mathcal{F}_3$ vs the choice $\alpha\mathcal{F}_3 = 0$.

% per 0.100 Bev/c



Λ° Momentum (Bev/c)

55,783-1

900 x 8840

27 26

