erable scatter in the estimates of both the cross section for $\pi N \to fN$ and the f^0 width. Since we do not wish to discuss or evaluate these discrepancies, we will simply take as a rough guess from the available data that $\sigma(\pi^- p \to f^0 n \to \pi^+\pi^- n) \approx 120$ μb at 5 GeV/c (with the same cuts used for the 4π data). This gives[9] a branching ratio

$$\frac{f^0 \to \pi^+\pi^+\pi^-\pi^-}{f^0 \to \pi^+\pi^-} \approx 10\,\%.$$

In order to get a rough idea of the $|t|$ dependence of the cross section we have carried out a similar analysis on the data without a $|t|$ cut. We find $N\rho_{00} = 69 \pm 21$ events (all t), in good agreement with the t distribution observed for $f^0 \to \pi^+\pi^-$.[10]

We have not discussed the possibility that the observed peak at 1.27 GeV could be the $D(1285)$. We note however that the width and $|t|$ distribution of our peak are in apparent disagreement with that quoted for the D.[11] We would also require that the spin of the D be ≥ 2.

We wish now to comment briefly on the narrow peak at $m_{4\pi} \sim 1.42$ GeV. The present data are clearly not sufficient to establish the presence of a resonance. If we suppose that the peak is not a statistical fluctuation, the data (Fig. 3) suggest that it may also have $J^P = 2^+$, and may therefore possibly correspond to the enhancement observed by Beusch et al.[12] in $K_1^0 K_1^0$.

We take pleasure in acknowledging the work of J. Kirz and O. Dahl in setting up the beam used in this experiment. We wish also to thank C. G. Howard and T. R. Palfrey for communicating to us their $\pi^- p \to \pi^+\pi^- n$ 5-GeV/c data prior to publication. Finally we wish to express our gratitude for the work of our engineers, scanners, and measurers.

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[5]$T_{22}(a_{13}, a_{24})$ for example, is proportional to $[(a_{13})_x + i(a_{13})_y]\,[(a_{24})_x + i(a_{24})_y]$.

[6]The form of Γ used is that of J. D. Jackson, Nuovo Cimento 34, 1644 (1964). The results presented here are rather insensitive to the choice of γ_ρ and $f_{\rho\pi\pi}$. The results shown were obtained with any of the choices $\gamma_\rho = 0.120$ or 0.148 GeV, $f_{\rho\pi\pi} = 1$ or $(1+q_0^2/0.71)^2/(1+q^2/0.71)^2$. We have bypassed the uncertainties in the energy dependence of $\Gamma(f^0 \to 4\pi)$ by forcing the $m_{4\pi}$ distribution of the fake events to be the same as the observed distribution.

[7]The projectors are

$$P(\rho_{00}) = 0.2 + P_2/Q_2 + 1.8P_4/Q_4,$$

$$P(\rho_{11} + \rho_{-1-1}) = 0.4 + P_2/Q_2 - 2.4P_4/Q_4,$$

$$P(\rho_{22} + \rho_{-2-2}) = 0.4 - 2P_2/Q_2 + 0.6P_4/Q_4,$$

where Q_2 and Q_4 are given in Eq. (3a).

[8]A. Forino et al., Phys. Letters 19, 65 (1965); M. Goldberg et al., ibid. 17, 354 (1965); C. G. Howard and T. Palfrey, private communication.

[9]According to our model we expect $(f^0 \to \pi^+\pi^+\pi^-\pi^-)/(f^0 \to 4\pi) = \frac{1}{3}$.

[10]C. G. Howard and T. Palfrey (unpublished) find 215/321 to be compared with 46/69.

[11]O. I. Dahl, L. M. Hardy, R. I. Hess, J. Kirz, and D. H. Miller, Phys. Rev. 163, 1377 (1967).

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ELECTROMAGNETIC DECAY OF THE $Y_0^*(1520)$†

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The decay of the $Y_0^*(1520) \to \Lambda + \gamma$ has been discovered in the reaction $K^- + p \to \Lambda +$ neutrals. The angular distribution and polarization of the Λ are consistent with a pure electric dipole transition. The cross section yields a partial width for the decay of 0.15 ± 0.03 MeV.

(A) Experimental procedure.—An exposure of 1.3×10^6 pictures in the Berkeley 25-in. hydrogen bubble chamber has yielded about 51 000 reactions of the type $K^- + p \to \Lambda +$ neutrals, $\Lambda \to p + \pi$. Among these reactions we have identified 258 events in which the missing mass of the neutral is consistent with zero and is kinematically cleanly separated from the mass of the neutral pion. The incident momenta ranged from 270 to 470 MeV/c. Most of the path length was close to

390 MeV/c, the incident momentum required to form the $Y_0^*(1520)$.

Following measurement of the events on the spiral reader, a three-constraint fit to the Λ decay was made and the mass of the missing neutrals was calculated. Cuts were then made to retain only events with (a) confidence level for the fit >0.01, (b) lambda projected length >2 mm, and (c) proton length >2 mm. About 42 000 events survived these cuts. The mean length of the Λ was 2.6 cm, and their mean life agreed with the accepted value.

Without further cuts the γ events could not be resolved from the π^0 events in the mass spectrum. The error in the square of the missing mass of the neutrals, MM^2, depends heavily on the error in the Λ momentum, which in turn depends on the uncertainty in the momentum of the decay proton. When the proton came to rest in the chamber, the proton momentum was determined from range, and this led to a mean error in MM^2 of about 0.1, in units of the pion mass. Events with leaving protons, however, were more poorly determined and had a mean error of about 0.5. Those events in which the Λ went backward in the center of mass were chosen for further investigation because they had a high probability for the proton to stop in the chamber.

For a more detailed investigation, events with backward Λ and with MM^2 less than 0.6 were remeasured, with special attention to scatterings in the tracks and to the accurate determination of the proton range when the proton stopped in the chamber. If remeasurement showed the proton to be leaving, the event was removed from the sample. Since the decay point was difficult to measure accurately for lambdas with a wide opening angle, events with $\cos(\Lambda,p) > 0.9$ were removed from the sample. The mass spectrum of unweighted events with stopping protons is shown in Fig. 1. The events with $MM^2 < 0.6$ are from the remeasured sample. The 258 events with $|MM^2| < 0.44$ were accepted as true γ events. The production cosine and decay cosine of these events are shown in Fig. 2. The unpopulated regions result from the cut on proton length (I), the cut on decay cosine (II), the requirement that the lambda go backward (III), and the requirement that the proton come to rest in the chamber (IV). The events were weighted to account for the fraction of the decay distribution removed by these cuts. In addition the events were weighted to account for Λ escape loss and the cut on the Λ length.

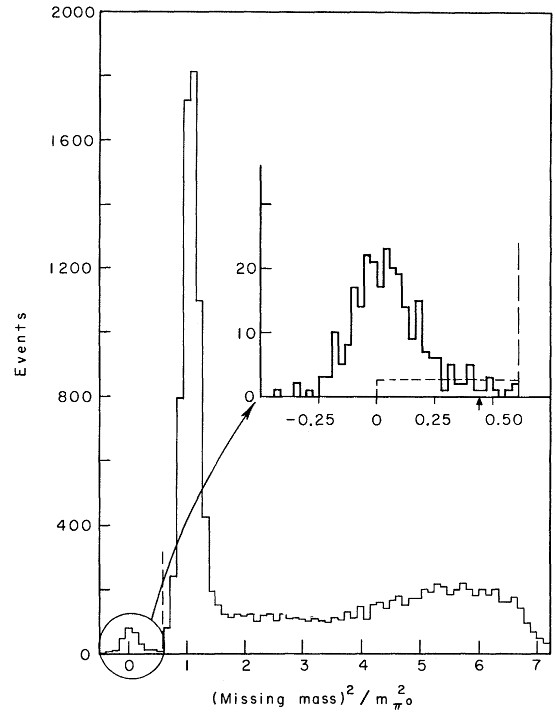

FIG. 1. Unweighted events versus (missing mass/m_{π^0})^2 for the reaction $K^- + p \rightarrow \Lambda +$ neutrals in which the proton from the Λ decay stops in the chamber. Events with (missing mass/m_{π^0})$^2 < 0.6$ are from the remeasured sample. The dashed rectangle is the estimated number of $\Sigma^0\gamma$ events.

Finally, in order to obtain the best value for each production angle and momentum, a one-constraint fit was made for those events with $MM^2 < 0.6$ to the complete sequence $K^- + p \rightarrow \Lambda + \gamma$,

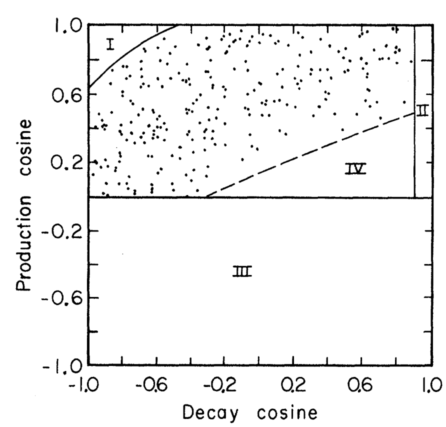

FIG. 2. The production cosine and decay cosine of the $\Lambda\gamma$ events. The unpopulated regions result from the short proton cut (I), the cut on decay cosine (II), the requirement that the Λ go backward (III), and the requirement that the proton come to rest in the chamber (IV).

$\Lambda \to p + \pi^-$; all events fitted with a confidence level >0.01.

(B) Results.—The production distribution for these events [Fig. 3(a)] is consistent with $5\text{-}3\cos^2\theta$, the distribution expected from a state of $J^P = \frac{3}{2}^-$ decaying by an electric dipole transition. Note that on account of our cut III only radiative decays into the forward c.m. hemisphere can be studied in this experiment. The expected distribution for a pure magnetic quadrupole transition is $1+\cos^2\theta$. Decays to pure helicity $\frac{3}{2}$ and $\frac{1}{2}$ states (which are linear combinations of $E1$ and $M2$) have decay distributions of $\sin^2\theta$ and $1+3\cos^2\theta$, respectively. None of these latter three appears consistent with the observed distribution.

The mean polarization of Λ is 0.17 ± 0.16. This is consistent with zero, as expected from the decay of a single spin and parity state.

For the calculation of the cross section for the reaction $K^- + p \to \Lambda + \gamma$, the number of $\Lambda\gamma$ events has been corrected to remove $\Sigma^0\gamma$ events, a fraction of which extend into the $\Lambda\gamma$ mass region. Assuming that the $Y_0^*(1520)$ is an SU(3) singlet and that the photon is a U-spin singlet, U-spin invariance requires that decay into the U-spin triplet linear combination $\Sigma^0 + \sqrt{3}\Lambda$ be zero. Thus the decay rates should be in the ratio $\Gamma(Y^* \to \Sigma^0 + \gamma)/\Gamma(Y^* \to \Lambda + \gamma) \approx 3 \times$(phase space) = 2.5. As the MM^2 spectrum of $\Sigma^0\gamma$ extends from 0 to 6.0 (see Fig. 1), the events with $MM^2 < 0.44$ should contain about 15% $\Sigma^0\gamma$. Subtraction of the estimated number of events leaves the mass spectrum symmetric about $MM^2 = 0$.

The cross section was then determined by comparing the number of $\Lambda\gamma$ events with the number of remaining neutrals, $\Lambda\pi^0$, $\Sigma^0\pi^0$, and $\Lambda\pi^0\pi^0$. The cross sections for the latter final states are known from previous measurements.[1] The angular distribution for the $\Lambda\gamma$ final state was assumed to be symmetric in the production cosine. The energy dependence of the cross section [Fig. 3(b)] clearly shows an enhancement at $E_{\text{c.m.}} = 1520$ MeV, confirming a new decay mode of the $Y_0^*(1520)$ into $\Lambda\gamma$. The cross section has been fitted with a Breit-Wigner shape of fixed mass and width ($M = 1519$, $\Gamma = 17.4$) plus an incoherent constant background. This gave a branching fraction of 0.86 ± 0.14%, yielding a partial width for $Y_0^*(1520) \to \Lambda + \gamma$ of 0.15 ± 0.03 MeV.

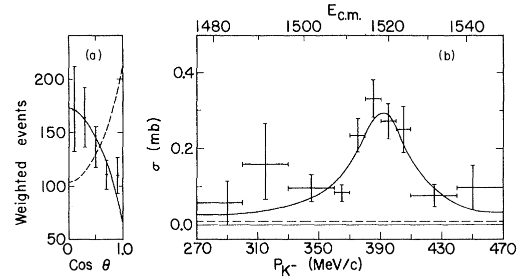

FIG. 3. (a) Weighted events versus production cosine of the γ. The solid curve, normalized to the total number of events, is $5\text{-}3\cos^2\theta$, corresponding to electric dipole decay. The dashed curve is $1+\cos^2\theta$, expected for magnetic quadrupole decay. (b) Cross section for $K^- + p \to \Lambda + \gamma$ in mb. The upper curve is the fit with a Breit-Wigner + constant background. The dashed line is the background.

This radiative width may be compared with the radiative widths of other $J^P = \frac{3}{2}^-$ states, which can be inferred from photoproduction experiments.[2] From these experiments we calculate $\Gamma[N^{*0}(1525) \to n + \gamma] = 0.35$ MeV and $[N^{*+}(1525) \to p + \gamma] = 0.47$ MeV. However, since $Y_0^*(1520)$ is predominantly an SU(3) singlet, its electromagnetic coupling is unrelated through SU(3) to the electromagnetic decays of these other resonances.

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