trum which peaks at 1.2 BeV/$c$. This spectrum agrees generally with the $K_L{}^0$ spectrum measured by W. Galbraith et al., private communication. If the peak of the spectrum is allowed to vary from 1.2 to 2.0 BeV/$c$, this relation is modified by only 10%.

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[8]We obtain $T_{\mu^+} = 2.17 \pm 0.04$ $\mu$sec compared with the accepted value of 2.199 $\mu$sec. For $T_{\mu^-}$ we obtain 2.00 $\pm 0.04$ $\mu$sec compared with the accepted value of 2.026 $\mu$sec for $\mu^-$ decaying in graphite (Ref. 7).

[9]To measure $P_P$, the only change was the use of other pion counters placed above and below the $K_2{}^0$ beam. To measure $P_L$ we used the same pion counters but revised the analyzer to measure the fore and aft asymmetry of the decay positrons. There was no significant difference in the sample of $K_2{}^0$ decays selected. This phase of the experiment will be discussed in more detail in a forthcoming article (J. A. Helland, M. J. Longo, and K. K. Young, to be published).

[10]The near equality of $P_T{}^{\text{lab}}$ and $P_T{}^{cms}$ is coincidental. $P_T{}^{\text{lab}}$ is the average polarization determined from our (biased) sample of events, while $P_T{}^{cms}$ is the corresponding average if all decays are detected and the decay plane is not tipped relative to the analyzer. The polarization in our sample is enhanced because our apparatus is designed to select events with larger-than-average polarization. This tends to be compensated by the fact that the decay plane is generally tipped relative to the horizontal.

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# DECAY RATES OF $Y_0$*(1520) AND ITS SU(3) CLASSIFICATION*

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Available data for the reaction $K^- + p \to Y_1^*(1765) \to Y_0^*(1520) + \pi$ are studied to obtain rates for $Y_0^*(1520)$ decaying into $\bar{K}N$, $\Sigma\pi$, and $\Lambda\pi\pi$ channels. The weighted average of all determinations of the ratio of squares of the reduced matrix elements for $\Sigma\pi$ and $N\bar{K}$ modes is found to have a value incompatible with the assumption that $Y_0^*(1520)$ is a pure SU(3) singlet. Therefore, either $Y_0^*(1520)$ is likely to be mixed with a $\frac{3}{2}^-$ octet or unbroken SU(3) branching ratio predictions are unreliable or difficult to compare with experiment.

In this paper we examine data from recent experiments[1-3] on the process $K^- + p \to Y_1^*(1765) \to Y_0^*(1520) + \pi^0$ to obtain decay fractions for the $Y_0^*(1520)$ resonance. In this momentum region (from 900 to 1100 MeV/$c$), $Y_0^*(1520)$ appears as a prominent peak with very little background (less than 10%) in the channels $K^-p$, $\Sigma^\pm\pi^\mp$, and $\Lambda\pi^+\pi^-$. Thus it is possible to measure, rather well, the resonant cross sections for the reactions

$$K^- + p \to Y_1^*(1765) \to Y_0^*(1520) + \pi^0$$

$$\hookrightarrow K^- + p \qquad (1)$$

$$\hookrightarrow \Sigma^\pm + \pi^\mp \qquad (2)$$

$$\hookrightarrow \Lambda + \pi + \pi. \qquad (3)$$

The different channel cross sections for $Y_0^*(1520)$ [hereafter called $\Lambda(1520)$] are given in terms of these cross sections [called $\sigma(1)$, $\sigma(2)$, and $\sigma(3)$, respectively].

$$\Lambda(1520) \to N + \bar{K} = \sigma(1)\{1 + F(n\bar{K}^0)/F(pK^-)\},$$

$$\Lambda(1520) \to \Sigma + \pi = \sigma(2)[1 + F(\Sigma^0\pi^0)/\{F(\Sigma^+\pi^-) + F(\Sigma^-\pi^+)\}],$$

$$\Lambda(1520) \to \Lambda + \pi + \pi = 1.5\sigma(3),$$

where $F(BM)$ is the phase space and angular-momentum barrier factor for the baryon-meson decay channel. The factor $F(BM) = q^5/(1 + q^2/X^2)^2$, where $q$ is the channel momentum in $\Lambda(1520)$ rest frame and $X$ is the inverse channel radius.[4]

The methods of extracting the cross sections $\sigma(1)$,[2] $\sigma(2)$,[1,2] and $\sigma(3)$[1,2] have been previously

Table I. Decay rates, partial cross sections, and ratio $R(\Sigma\pi/N\bar{K})$ for $\Lambda(1520)$.

| | | Decay rates and cross sections $\Sigma\pi$ | $N\bar{K}$ | $\Lambda\pi\pi$ | $R(\Sigma\pi/N\bar{K})$ $X=0.2$ | $X=0.4$ | $X=1.0$ |
|---|---|---|---|---|---|---|---|
| 1 | Combined data[a-c] | 1.06 ± 0.15 mb 42 ± 5 % | 1.22 ± 0.11 mb 47 ± 5 % | 0.27 ± 0.06 mb 11 ± 7 % | 0.67 ± 0.11[d] | 0.60 ± 0.10[d] | 0.57 ± 0.10[d] |
| 2 | Dauber[e] | 0.12 ± 0.01 mb 34 ± 4 % | 0.17 ± 0.03 mb 52 ± 4 % | 0.034 ± 0.005 mb 11 ± 2 % | 0.54 ± 0.07[d] | 0.49 ± 0.08[d] | 0.46 ± 0.07[d] |
| 3 | Hardy[f] | 45 ± 4 % | 47 ± 9 % | 8 ± 2 % | 0.75 ± 0.22[g] | 0.66 ± 0.19[g] | 0.61 ± 0.18[g] |
| 4 | Watson[h] | 55 ± 7 % | 30 ± 4 % | 15 ± 2 % | 1.45 ± 0.35[g] | 1.29 ± 0.33[g] | 1.19 ± 0.31[g] |
| | Weighted average of row 1, 2, and 3. | | | | 0.61 ± 0.07 | 0.55 ± 0.06 | 0.51 ± 0.05 |
| | Weighted average of row 1, 2, 3, and 4. | | | | 0.64 ± 0.09[g] | 0.57 ± 0.08[g] | 0.52 ± 0.08[g] |

[a]Ref. 1.
[b]Ref. 2.
[c]Ref. 3.
[d]Computed from partial cross sections.
[e]P. M. Dauber, E. Y. Malamud, P. E. Schlein, W. E. Slater, and D. H. Stork, University of California at Los Angeles Report No. UCLA-1015, 1967 (to be published).
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[g]Errors in $\Sigma\pi$ and $N\bar{K}$ percentages assumed completely correlated.
[h]Ref. 5.

published and will not be reproduced here. We quote only the results:

$$\sigma(1)=0.65\pm0.05\text{ mb},$$
$$\sigma(2)=0.70\pm0.10\text{ mb},$$
$$\sigma(3)=0.18\pm0.04\text{ mb}.$$

Using these values we obtain the percentages and partial cross sections given in Table I. The percentage decay rates obtained from the formation experiment[5] $K^-+p\to\Lambda(1520)\to B+M$ and from experiments studying different production reactions at higher energies[6,7] are also given in Table I. From the percentage decay rates or from the partial cross sections for $\Lambda(1520)\to N+\bar{K}$ and $\Sigma+\pi$, we calculate the ratio of the square of the reduced matrix elements $R$ for $\Lambda(1520)$ decaying into $\Sigma\pi$ and $N\bar{K}$ channels by the formula

$$[\Lambda(1520)\to\Sigma+\pi]/[\Lambda(1520)\to N+\bar{K}] = [F(\Sigma\pi)/F(N\bar{K})]R.$$

Table I gives $R$ for individual experiments for three values of $X$, namely 0.2, 0.4, and 1.0 GeV.

The weighted average $\bar{R}$ from all four evaluations varies with $X$ from $0.64\pm0.09$ to $0.52\pm0.08$. {The errors have been multiplied by a chi-squared scale factor $S=[X^2/(N-1)]^{1/2}$ to combine the data which are scattered by about two standard deviations.[8]} The weighted average $\bar{R}$, computed not including Watson, Ferro-Luzzi, and Tripp,[5] varies with $X$ from $0.61\pm0.07$ to $0.51\pm0.05$. For comparison with SU(3) predictions we will use the value $\bar{R}=0.64\pm0.09$ obtained with $X=0.2$.

It has often been assumed that $\Lambda(1520)$ is a unitary singlet.[9-11] The lack of detection of the decay $\Lambda(1520)\to\Sigma(1385)+\pi$ corroborates this assignment. If $\Lambda(1520)$ is a pure unitary singlet, then one predicts $R(\Sigma\pi/N\bar{K})=1.5$. The measured value $\bar{R}=0.64\pm0.09$ (with $X=0.2$) is more than nine standard deviations from the SU(3) value. The disagreement worsens if $X$ is chosen to be larger. To determine a scale for the reliability of SU(3) decay-rate predictions we examine the decays of the $\frac{3}{2}^+$ decuplet.[4,12] For the well-established $\frac{3}{2}^+$ decuplet, experimental rates for $\Delta(1236)\to N+\pi$ and $\Sigma(1385)\to\Lambda+\pi$ or $\Sigma+\pi$ agree reasonably well with SU(3) predictions (confidence level of 20%); however rates for the decay $\Xi^*(1530)\to\Xi+\pi$ are compatible with SU(3) prediction only at the 1% confidence level of a chi-squared test (this corresponds to a 2.7-standard-deviation discrepancy). However, for the $\Lambda(1520)$ the disagreement with SU(3) prediction, as pointed out above, is nine standard deviations which is substantially greater than the 2.7 standard deviation for the $\frac{3}{2}^+$ decuplet.

We may interpret this disagreement in two ways: (a) that $\Lambda(1520)$ is not a pure SU(3) singlet and is likely to be mixed with a $\frac{3}{2}^-$ octet, or (b) that unbroken SU(3) predictions of decay rates, which relate $\Sigma\pi$ and $N\bar{K}$ channels, are unreliable or difficult to compare with experiment.

It has been suggested that violation of the Gell-Mann–Okubo[4,9] mass formula in the $\frac{3}{2}^-$ octet could conceivably be due to mixing with an isosinglet. If $N(1518)$, $\Sigma(1660)$, $\Xi(1660)$, and $\Xi(1820)$ are members of the $\frac{3}{2}^-$ octet[9-14] then the mass of the $I=0$, $Y=0$ member should be $M_8=1672$ MeV. The recently discovered $\Lambda(1700)$[15-17] and $\Lambda(1520)$ may be combined with the above states to form a $\frac{3}{2}^-$ nonet. Then the isosinglet mass is obtained to be $M_1=1548$ and the mixing angle is found to be about 22°. We do not discuss decay rates quantitatively for this suggested nonet because it is not possible to fit simultaneously all of the $\Sigma(1660)$ and $\Xi(1820)$ decay rates for any value of $\underline{8}$ and $\underline{8}^1$ mixing parameter[4,12] and no octet-singlet mixing will improve this fit. Such a mixing scheme is compatible with the assignment of $\frac{3}{2}^-$ octet and singlet to the $\underline{1134}$ representation of SU(6).[11]

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