These theories predict that $\alpha_\Lambda \approx -\alpha_{\Sigma^0}$, where α_{Σ^0} is the asymmetry parameter for $\Sigma^+ \rightarrow \pi^0 + p$. With the result $\alpha_{\Sigma^0} = -0.73_{+0.11}^{-0.16}$ of Beall *et al.*[12] the prediction of the theory is fulfilled. (Note that our sign convention is used here. A negative sign means negative proton helicity.) Precise numerical agreement cannot be expected since the theories assume no mass difference between the Λ^0 and $\Sigma^\pm$ hyperons. Further, the theories assume the $|\Delta T| = \frac{1}{2}$ rule for nonleptonic decays which appears to be satisfied experimentally, although there appears to be one discrepancy which should be explored. That is the prediction of the $|\Delta T| = \frac{1}{2}$ rule that $|\alpha_{\Sigma^0}| = 0.99_{-0.05}^{+0.01}$,[19] compared with the experimental result of $-0.73_{+0.11}^{-0.16}$. Corrections to the theory because of mass differences will tend to reduce the p-wave amplitude relative to the s-wave amplitude in the Λ^0 decay because of angular momentum barriers. This effect may produce the low $|p|/|s|$ rato found for the Λ^0 decay in this experiment.

odd Σ-Λ relative parity which predict the same result, i.e., $\alpha_{\Sigma^0} \approx -\alpha_\Lambda$. See Jugoro Iizuka and Reinhard Oehme, Phys. Rev. **126**, 787 (1962).

[19] J. W. Cronin, *Proceedings of the 1960 Annual International Conference on High-Energy Physics at Rochester* (Interscience Publishers, Inc., New York, 1960), p. 590.

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K^* Spin and the Isovector Kaon Charge*

ALBERTO PIGNOTTI†
Lawrence Radiation Laboratory, University of California, Berkeley, California
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The isovector kaon charge is calculated using an unsubtracted dispersion relation for the kaon form factor. The $\pi\pi$-$K\bar{K}$ amplitude appearing in the form factor discontinuity is evaluated by using unitarity and crossing symmetry, and thus is related to the experimental values of the ρ and K^* energies and widths. It is shown that the correct order of magnitude for the kaon charge is obtained if the K^* spin is one and not if it is zero.

THERE has been considerable discussion recently on the spin assignment to the K^* resonance based on the analysis of various experiments.[1–3] The purpose of this note is to show that if the spin of the K^* is assumed to be one, good agreement is obtained for the isovector charge of the kaon,[4] while no such agreement can be obtained if the K^* spin is zero. Throughout this work the approximation of retaining only the ρ-meson contribution in the $I=1$, $J=1$ channel is performed, and the K^* is assumed to be the only effective πK resonance.

The isovector kaon form factor satisfies the dispersion relation[5]

$$F_K(t) = \frac{1}{\pi} \int_4^\infty \frac{2q'^3 F_\pi^*(t') B_1^{(-)}(t')}{(t')^{1/2}(t'-t)} dt', \tag{1}$$

where $q' = [(t'/4) - 1]^{1/2}$, $B_1^{(-)}(t)$ is the $I=1$, $J=1$

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† On leave from Universidad de Buenos Aires, Buenos Aires, Argentina.

[1] M. Alston, G. Kalbfleisch, H. Ticho, and S. Wojcicki have reported on a study of some angular distributions which are consistent with spin zero [Proceedings of the 1962 International Conference on High-Energy Physics at CERN (CERN Scientific Information Service, Geneva, 1962); also Lawrence Radiation Laboratory Report UCRL-10232, 1962 (unpublished)].

[2] R. Armenteros *et al.* have ruled out spin zero in studying the K^* production in $(p\bar{p})$ annihilation at rest. See R. Armenteros, L. Montanet, D. R. O. Morrison, A. Shapira, S. Nilsson, J. Vandermeulen, Ch. D'Andlau, A. Astier, C. Ghesquiere, B. P. Gregory, D. Rahm, P. Rivet, and F. Solmitz [Proceedings of the 1962 International Conference on High Energy Physics at CERN (CERN Scientific Information Service, Geneva, 1962); also CERN/TC/PHYSICS 62-9 (unpublished)].

[3] W. Chinowsky, G. Goldhaber, S. Goldhaber, W. Lee and T. O'Halloran also ruled out spin zero by studying the process $K^+ + p \rightarrow K^* + N_{33}^*$ [Phys. Rev. Letters **9**, 330 (1962)].

[4] A qualitative argument in this direction was given by G. Frye [Nuovo Cimento **18**, 282 (1960)]. S. K. Bose recently studied the isovector kaon form factor, using a subtracted dispersion relation [Nuovo Cimento **24**, 970 (1962) and errata (to be published)]. The method used involves a divergency in the case of a spin-one K^*, so that a cutoff is needed. No conclusion is drawn on the spin of the K^*.

[5] F. Ferrari, G. Frye, and M. Pusterla, Phys. Rev. **123**, 308 (1961).

amplitude for the $\pi\pi - K\bar{K}$ process as defined by Lee,[6] and the pion mass is taken to be one. Here $F_\pi(t)$ is the pion form factor normalized to one at $t=0$ and is given by

$$F_\pi(t)=\frac{1}{D_\rho(t)}=\frac{t_\rho}{t_\rho-t-i\gamma[(t-4)^3/t]^{1/2}\theta(t-4)}, \quad (2)$$

where t_ρ and γ are the energy squared and reduced width of the ρ meson, respectively, and $\theta(x)$ is the usual step function.

In order to calculate $B_1^{(-)}(t)$, it is convenient to define the function

$$\Gamma(t)=B_1^{(-)}(t)D_\rho(t), \quad (3)$$

which has the same singularities as $B_1^{(-)}(t)$ except for the right-hand cut due to the ρ intermediate state. The left-hand cut in $\Gamma(t)$ starts at $t\cong-16$ if the lowest energy intermediate state in the crossed channels (πK channels) is the K^* resonance at 885 MeV, and the right-hand cut starts effectively at the value of the square of the energy of the first significant state in the $J=1$, $I=1$ channel above the ρ meson. The dispersion relation for $\Gamma(t)$ can be evaluated in the kernel approximation first used by Balázs,[7–10] which provides a means of taking into account with reasonable accuracy the contribution from the left-hand cut and even some contribution from the inelastic cut. The result is a two-pole expression for $\Gamma(t)$:

$$\Gamma(t)=\frac{\alpha_1}{t-p_1}+\frac{\alpha_2}{t-p_2}. \quad (4)$$

The positions of the poles in Eq. (4) are essentially determined by the approximation procedure, and the values $p_1=-21$ and $p_2=-200$ are used, in agreement with the criterion used by Balázs[9] and Singh and Udgaonkar.[11] The residues α_1 and α_2 are determined by analytic continuation from the crossed channels in which only the K^* is retained in the δ-function approximation. For this purpose the P wave in the t channel is projected from a fixed-t dispersion relation. This gives

$$B_1^{(-)}(t)=\frac{2M^{*2}\Gamma^*}{3k^*p^2q^2}(2l^*+1)P_{l^*}\left(1+\frac{t}{2k^{*2}}\right)\times Q_1\left(\frac{2M^{*2}-2M^2-2+t}{4pq}\right), \quad (5)$$

where Γ^* is the half-width of the K^*, l^* is the spin of the K^*, M^* is the K^* energy, M is the kaon mass, $p^2=t/4-M^2$, $q^2=t/4-1$, and

$$k^{*2}=[M^{*2}-(M+1)^2][M^{*2}-(M-1)^2]/4M^{*2}.$$

Equations (3), (4), and (5) evaluated at $t=-1$ and $t=-2$ are used to calculate the residues α_1 and α_2. At these values of t the improved expression of Singh and Udgaonkar for $D_\rho(t)$ is used.[11]

With the above results one can compute the integral in Eq. (1), which, according to the normalization used, should yield $\frac{1}{2}$ for $t=0$. Integrating with the help of the usual δ-function approximation and using 25 and 50 MeV for the half-widths of the K^* and ρ, one obtains

$$\begin{aligned} F_K(0)&\cong\tfrac{1}{2}\times1.6 \quad \text{for} \quad l^*=1 \\ &\cong\tfrac{1}{2}\times0.06 \quad \text{for} \quad l^*=0. \end{aligned} \quad (6)$$

These results[12] are directly proportional to the K^* width and inversely proportional to the ρ width. Now the experimental values for these widths are not well established, and further, one does not expect the entire vector charge of the kaon to be due to the two-pion contribution. However, within these approximations it is clear from Eq. (6) that one can obtain the kaon charge if the spin of the K^* is one but not if it is zero.

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[6] Benjamin W. Lee, Phys. Rev. **120**, 325 (1960).
[7] L. Balázs, Phys. Rev. **125**, 2179 (1962).
[8] L. Balázs, Phys. Rev. **128**, 1935 (1962).
[9] L. Balázs, Phys. Rev. **128**, 1939 (1962).
[10] L. Balázs, Phys. Rev. **129**, 872 (1963).
[11] V. Singh and B. M. Udgaonkar, Phys. Rev. **128**, 1820 (1962).

[12] In order to see how sensitive these results are to a variation in the positions of the poles p_1 and p_2, the extreme case of $p_1=-13.5$ and $p_2=-186$ has been considered. Although this corresponds to placing a pole outside the left-hand cut (which starts at $t\cong-16$) the value for the $l^*=1$ case is only decreased by 15%, while the result for $l^*=0$ is increased by a factor of two. On the other hand, a displacement of the left pole to -2×10^6 increases the result for the P-wave case by 10% and decreases the S-wave result by 22%.