from a knowledge of the two-body kinematics and the bremsstrahlung end-point energy since, for a $1/k$ bremsstrahlung distribution, the cross section per equivalent quantum for a particular state is independent of the peak photon energy once threshold is passed. Thus an excitation function in which the bremsstrahlung end point is varied consists ideally of a series of steps modified by the spectrometer resolution and, more significantly in the cases to be discussed here, by the natural width of the resonances.

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NEW STRUCTURES IN THE K^+-p AND K^+-d TOTAL CROSS SECTIONS BETWEEN 1.55 AND 3.30 GeV/c *

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Two new $I = 1$ structures about 0.2 mb in height are observed in K^+-p and K^+-d total cross-section measurements at c.m. energies of 2190 ± 10 and 2505 ± 10 MeV.

The K^+-p and K^+-d total cross sections have been measured with increased precision and resolution in the momentum interval 1.55 to 3.30 GeV/c using a partially separated K^+ beam at the Brookhaven alternating-gradient-synchrotron (AGS).[1] Data were obtained at momentum intervals of 50 MeV/c with $\Delta p/p = \pm 0.75\,\%$. The statistical standard deviations are approximately $\pm 0.25\,\%$ for hydrogen and $\pm 0.13\,\%$ for deuterium. Analysis of the data indicates two structures both in isospin one. Their probable interpretation is ambiguous between that of threshold effects and of new baryon resonances with positive strangeness.

The experimental setup was similar to that used to measure $\bar{p}$-p and $\bar{p}$-d total cross sections.[2] There were two differences: (1) For momenta greater than 2.3 GeV/c, a high-pressure gas differential Cherenkov counter[3] was used instead of the liquid differential Cherenkov counter; and (2) no time-of-flight selection was used. Both Cherenkov counters provided a coincidence output for kaons and an anticoincidence for faster particles. The beam flux varied from about 2.5×10^4 K^+ at 3.3 GeV/c to 2.5×10^3 K^+ at 1.6 GeV/c for 10^{12} circulating protons.

In Figs. 1(a) and 1(b) the measured cross sections are plotted versus the laboratory momentum. Also shown are data of Cool *et al.*[4] between 1.0 and 2.4 GeV/c. The error bars shown represent statistical errors only. It

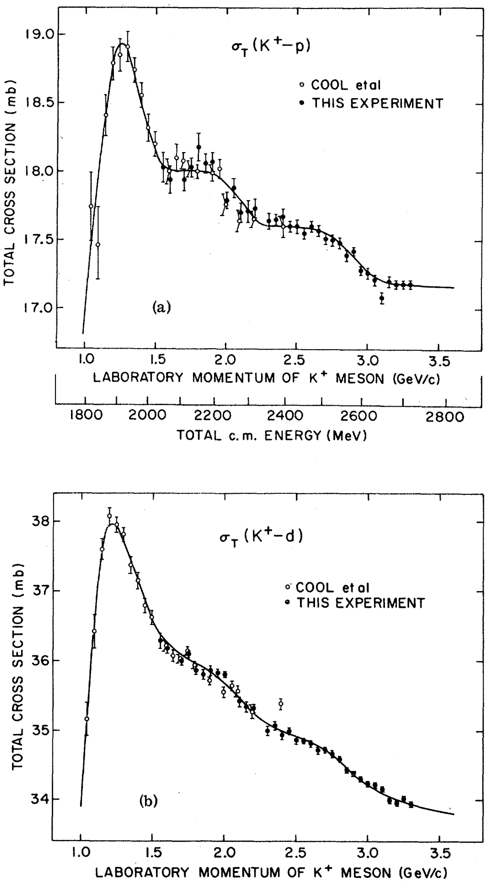

FIG. 1. The total cross section of K^+ mesons on (a) protons and (b) deuterons. Errors represent statistical standard deviations.

is estimated that an overall systematic error of less than ±1 % is present in the absolute cross-section scale of the data; it is expected that this error is essentially independent of momentum. Our results are in good agreement with the results of previous measurements in this momentum interval.[4-8] Only the data of Ref. 4 are displayed in Figs. 1(a) and 1(b) since earlier data had considerably larger statistical errors.

In addition to the structures near 1.25 GeV/c which were previously reported,[4] new small structures are present in the K^+-p and K^+-d total cross sections at about 1.8 and 2.6 GeV/c. The K^+-p total cross sections are purely $I=1$. The computation of the $I=0$ cross sections from the proton and deuteron data was done in the same way as for our previous experiments.[2,4] The calculation leads to two structures in the $I=0$ cross section at about the same momenta as the two in $I=1$. Since the structures are small and close to our experimental sensitivity, we have tested their statistical significance by computing the χ^2 probability for smooth-curve fits to the data with and without structures in the $I=0$ and $I=1$ cross sections.

The $I=1$ structure at 2.6 GeV/c cannot be eliminated on statistical grounds. The $I=0$ structure in the same energy region is not statistically significant, since its elimination reduces the confidence level of a fit to the data only from 75 to 30 %.

In the region around 1.8 GeV/c, the elimination of both the $I=0$ and $I=1$ structures is not acceptable on statistical grounds. If one tries to eliminate the $I=0$ structure, the confidence level of a fit to the data drops from 80 to 20 %, while the elimination of the $I=1$ structure, leaving in the $I=0$ only, reduces the confidence level to 4 %. We conclude that there is at least one structure around 1.8 GeV/c, the $I=1$ being strongly favored.

The solid curves in Figs. 1(a) and 1(b) represent the best fits to the data with two $I=1$ and no $I=0$ structures at momenta greater than 1.5 GeV/c. The corresponding $I=0$ cross section is shown in Fig. 2. It must be noted that the existence of an $I=0$ structure of magnitude comparable to the two $I=1$ bumps (about 0.2 mb) could not be conclusively demonstrated by the present experiment since the errors on the $I=0$ cross section are almost a factor of four larger than the errors on the $I=1$ (K^+p) cross section.

The simplest and most conservative interpretation of the $I=1$ structures is that they arise from threshold effects of one or several nucleon isobars and/or of $K^*(890)$. If, instead, the two structures were due to resonances with $Y=2$, $S=+1$, and $I=1$, they would have masses of 2190 ± 10 and 2505 ± 10 MeV, full widths at half-height of 120 MeV, resonant cross sections of 0.2 mb, and values of $(J+\frac{1}{2})\times\kappa$ equal to 0.03 and 0.04, where J and κ would be their spins and elasticities, respectively. They would be rather inelastic resonances; furthermore, they would be members of the $\underline{27}$ representation of SU(3). For the nonrelativistic quark model of elementary particles[9] one would require five quarks to form $Y=2$, $S=+1$ states.

A phase-shift analysis of elastic and inelastic data at different energies[10] indicates the possibility that the P_{11} phase could resonate at a laboratory momentum of 1.5 GeV/c. It is possible that this fact is connected with our structure at 1.85 GeV/c.

Additional indication for possible $Y=2$, $S=+1$, $I=1$ states comes from a K^- photoproduction experiment.[11]

The data available do not allow more definite statements to be made.

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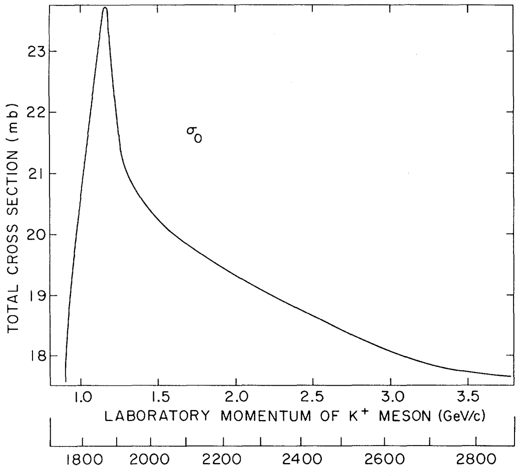

FIG. 2. The total cross section in the $I=0$ isospin state, assuming that there are no new structures above 1.4 GeV/c. The existence of structures comparable in magnitude to the $I=1$ structures cannot be excluded.

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K^0 PHOTOPRODUCTION CROSS SECTIONS COMPARED TO QUARK-MODEL PREDICTIONS[*]

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The upper limit of the ratio of K^0 production from the neutron to that from the proton at forward c.m. angles is determined experimentally. This limit is about 20 times less than the ratio predicted on the basis of quark wave functions, at the energies of this experiment. The maximum Q value for these reactions is 240 MeV, with forward three-momentum transfers in the range 260-390 MeV/c.

The K^0 photoproduction from nucleons has been studied at forward c.m. angles with the Caltech electron synchrotron. The ratio of K^0 production from the neutron will be compared with recent theoretical predictions by Kupsch[1] and by Rubinstein, Scheck, and Socolow.[2] In both papers, the authors assume that the photon interacts directly with a single quark in the nucleon resulting in a predominantly forward scattered meson. The reaction amplitudes can be expressed in terms of the wave function predicted by the quark model for the baryons. The pseudoscalar-meson reactions can be expressed in terms of a single amplitude and similar predictions of ratios of cross sections were independently made by the above authors.[1,2]

The three reactions studied experimentally which can be compared to the predicted ratios are

$$\gamma + n \to K^0 + \Sigma^0, \tag{1}$$

$$\gamma + p \to K^0 + \Sigma^+, \tag{2}$$

$$\gamma + n \to K^0 + \Lambda^0. \tag{3}$$

The theoretical ratios for these reactions before kinematic corrections are 1:2:27.[1,2]

The cross sections for Reaction (2) have been determined[3,4] for the backward c.m. Σ^+ (forward K^0) in the course of an emulsion experiment which measured the magnetic moment