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NEW DIRECTIONS IN $\pi\pi$ AND $K\pi$ EXPERIMENTS*

Status of a 13 GeV $K^{\pm}p$ Experiment at SLAC

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ABSTRACT

A new SLAC experiment to study $K\pi$ scattering using both K^+p and K^-p reactions at 13 GeV is described.

A session on new directions in $\pi\pi$ and $K\pi$ experiments permits a diversity of possible topics for emphasis. My remarks will be confined to a discussion of the tasks immediately ahead in the $\pi\pi$ and $K\pi$ resonance regions using the data from the present generation of experiments,[1-5] and to a brief report on a new experiment in progress at SLAC to study $K\pi$ scattering using the reactions K^+p and K^-p at 13 GeV.

Recent experiments and analyses[1-6] exhibit general agreement on the qualitative results of $\pi\pi$ and $K\pi$ scattering in the lower mass region below the d wave. However, there are still a number of questions to be further studied and confirmed, especially in $K\pi$ scattering. One area for subsequent analyses to explore concerns the features of the higher mass region, such as studying the possible s wave resonances in the f^o and K*(1400) regions,[6-8] and verifying the existence of and/or determining the parameters of higher mass states such as the spin 3 K*,[9] or even the ρ'. A second area to focus on concerns the quantitative uncertainties of the present phase shifts in the low mass region. In the case of the I=0 $\pi\pi$ s wave, how are we to interpret and choose between the range of solutions that have been presented,[1,3,6] all qualitatively consistent, but exhibiting systematic differences? In the $K\pi$ system, can we definitely rule out the existence of a narrow K* s wave resonance near the K*(890)?[4,5]

Future experiments must address themselves to these issues. In this regard, the ultimate limitation of these experiments is in understanding the extrapolation to the pion pole. This in turn implies a need for as detailed an understanding as possible of the $\pi\pi$ and $K\pi$ production amplitudes in the physical region and an attempt to construct experiments that have cross checks on the specific extrapolation procedures employed.

With these remarks in mind, let me now turn to a brief report on an experiment at SLAC[10] which, among other topics, will study $K\pi$ scattering. The experiment involves a study of both K^+p and K^-p reactions at 13 GeV. Figure 1 shows a plan view of the apparatus. The experiment uses a conventional wire spark chamber dipole spectrometer to detect the decay products of the peripherally produced mesons. The magnet aperture is 72 in. wide by

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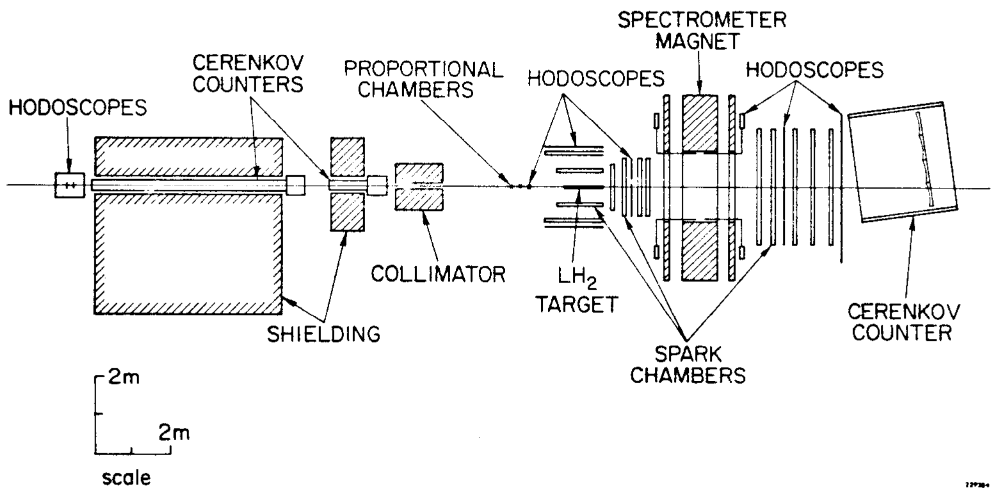

Fig. 1. Plan view of experimental apparatus.

24 in. high. Scintillation counter hodoscopes, Cerenkov counters and proportional chambers are used to detect each incident K in the rf separated beam. The trigger requirement is simply that 2 or more charged particles pass through the spectrometer after originating from an interaction in the 1 meter hydrogen target. The large aperture cellular Cerenkov counter is used to give K, π-identification of the meson decay products.

The relatively loose trigger criteria allow us to study a wide range of final states; the dominant processes are listed in Table I. The event numbers

Table I Observed event rates (13 GeV, K^+p, K^-p)

Process	Events	Process	Events
$K^+p \to K^+\pi^-\Delta^{++}$	115,000	$K^-p \to K^-\pi^+n$	48,000
$\to K^*(890)\Delta^{++}$	45,000	$\to K^*(890)n$	18,000
$\to K^*(1400)\Delta^{++}$	14,500	$\to K^*(1400)n$	6,500
$K^+p \to K^+\pi^+n$	8,500	$K^-p \to K^-\pi^-\Delta^{++}$	
$K^+p \to K^o\pi^+p$	14,000	$K^-p \to \bar{K}^o\pi^-p$	11,000
$\to K^*(890)p$	9,600	$\to K^*(890)p$	7,500
$K^+p \to (K^+\pi^+\pi^-)p$	46,000	$K^-p \to (K^-\pi^-\pi^+)p$	36,000

quoted are based on the observed reconstructed event rates for the first half of the data, and these are then projected to the full data sample. For the K^+p data, in addition to the dominant $K^+p \to K^+\pi^-\Delta^{++}$ channel, we also detect $K^+p \to K^+\pi^+n$ to study the I=3/2 states and $K^+p \to K^o\pi^+p$. The large sample of $(K^+\pi^+\pi^-)p$ events will be used for a study of the Q meson. Some additional information on the higher multiplicity channels corresponding to inelastic $K\pi$ scattering will also be obtained. The corresponding processes will be obtained from the K^-p data and these have been included in the table.

In order to give a more tangible feeling for the experiment, Fig. 2 shows the observed $K^+\pi^-$ mass distribution for the reaction $K^+p \to K^+\pi^-\Delta^{++}$ from about 5% of the final data sample. Figure 2 contains about 6000 events, and in fact, this uncorrected mass spectrum is quite similar to those observed in bubble chambers for this reaction. The mass resolution for the 13 GeV K^0 from the reaction $K^+p \to K^0\Delta^{++}$ has a FWHM of 12 MeV. A traditional concern with spectrometer data is the angular acceptance, i.e., the acceptance as a function of the K* decay angles in the s or t channel production frame. For the $K\pi$ case, in contrast with $\pi\pi$ data, the acceptance is good over the entire backward half of the angular distribution, a consequence of the Lorentz transformation properties of the K. There remains an acceptance loss for events with a low momentum backward pion.

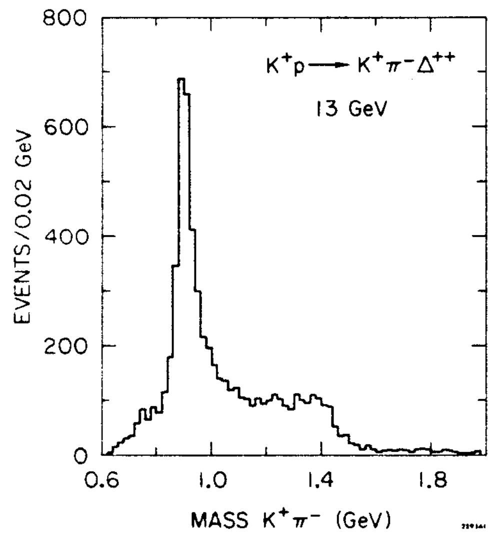

Fig. 2. Uncorrected $K^+\pi^-$ mass distribution for $K^+p \to K^+\pi^-\Delta^{++}$.

Let me summarize the present status of the experiment. About half of the data has been recorded, and the rest will be obtained this summer (1973). The reconstruction programs are in production on the first part of the data, and we are currently working on folding in the apparatus acceptance with the data in order to obtain the corrected $K\pi$ cross section and moments in the physical region.

Finally, I would like to emphasize some of the features of this experiment relevant to a study of $K\pi$ scattering, in addition to the obvious point of high statistics data with good mass resolution.

The first point is that we are studying $K\pi$ scattering for two reactions; first where the target proton dissociates into a π^+n and secondly into $\pi^-\Delta^{++}$. The neutron and Δ^{++} reactions have different t dependence characteristics in the physical region. An important cross check on the results obtained to describe $K\pi$ scattering after extrapolation to the pion pole is that they must be the same for both reactions. The quality of the extrapolated results is related to the ability to understand and extract the pion exchange contribution in the physical region. An important aspect of the π exchange study is that one obtains a unified description of both the neutron and Δ^{++} data, and even further that this phenomenology should describe both $\pi\pi$ and $K\pi$ production. Differences between $\pi\pi$ and $K\pi$ production in the physical region are expected and will be an interesting aspect of our data since additional exchanges can contribute in the $K\pi$ system.

The second point is an extension of the first. This concerns the fact that we will have good data on the pure I=3/2 channel for both the n and Δ^{++} processes mentioned above for the neutral $K\pi$ system. This means one can group the pairs of reactions ($K^+p \rightarrow K^+\pi^-\Delta^{++}$, $K^-p \rightarrow K^-\pi^-\Delta^{++}$) and ($K^-p \rightarrow K^-\pi^+n$, $K^+p \rightarrow K^+\pi^+n$) and process the data, extrapolate, and analyze each pair in a consistent way. This should lead to a good knowledge of the relative cross sections internal to a single experiment and hence remove some of the uncertainties associated with specifying the small I=3/2 contributions.

The last point concerns the angular acceptance characteristic that we do detect the backward K. As a result, we expect to be able to study questions associated with higher spin partial waves such as the s wave behavior in the K*(1400) region.

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