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NEW RESULTS ON HYPERCHARGE EXCHANGE REACTIONS FROM LASS*

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ABSTRACT

New results from a number of final states ($\eta\pi^-\pi^+$, $\bar{K}^*K^*$, $\phi\phi$) produced by hypercharge exchange in LASS by an 11 GeV/c K^- beam are described, and compared with results from other hadroproduction modes and from J/ψ decay.

Introduction

The non-relativistic quark model provides a good description of most of the known light quark spectra [1,2]. The experimental situation is particularly well understood in the strange meson sector and some progress has been made recently in understanding the strangeonia [3].

However, structures have been reported recently in final states with hidden strangeness, where strangeonia might be expected, produced by several different mechanisms. A search for production via hypercharge exchange in LASS is of interest in elucidating the nature of these effects. Hypercharge exchange is an excellent mechanism for selecting states with $s\bar{s}$ content and, it is very useful to compare our data with the same meson final states produced in different ways.

The LASS spectrometer is serviced by a clean RF separated beam, and has nearly flat acceptance over 4x steradians, good particle identification, good multi-particle tracking and topology reconstruction, a full acceptance trigger, and high data rate capability [4]. The raw data sample contains -113 million triggers taken with an 11 GeV/c K^- beam, corresponding to a sensitivity of 4.1 events/nb.

The principal results of analyses of the reactions:

$$K^-p \rightarrow \eta\pi^-\pi^+\Lambda \qquad (1)$$

$$K^-p \rightarrow \bar{K}^*K^*\Lambda \qquad (2)$$

$$K^-p \rightarrow \phi\phi\Lambda \qquad (3)$$

together with some features of

$$K^-p \rightarrow K^-K^0_S\pi^+\Lambda \qquad (4)$$

are described below, full details can be found in [5]. All final states are fully reconstructed, except for π°, and kinematically constrained.

Description of Results

The $\eta\pi\pi$ system in reaction (1) has been studied by the $\pi^+\pi^-\pi^\circ$ decay mode of the η. Aside from a clear η' (fig. I), there is no very obvious structure in the rest of the $\eta\pi\pi$ spectrum shown in fig. 2. The total cross section for η' production is found to be 8.9±0.6 μb.

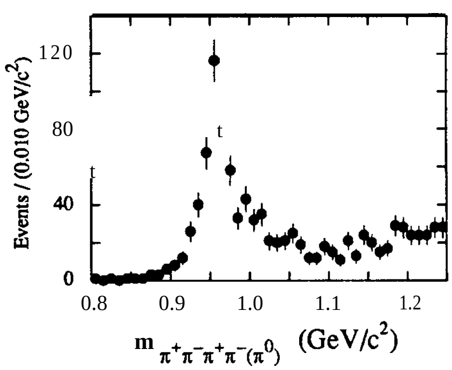

Fig. 1 The low end of the 5π spectrum of reaction (1).

Selection of events where $\Lambda\pi^+$ lies in the $\Sigma(1385)^+$ mass region allows study of the poorly understood $a_0(980)$. The $\eta\pi^-$ (not shown) and $K^-K^0_S$ mass spectra from reactions (1) and (4) show the $a_0(980)$ and can be simultaneously fitted with the model of Flatté [6] if a background term is included. Figure 3 shows that the $K^-K^0_S$ mass spectrum is well described by the $K\bar{K}$ molecule model of Weinstein and Isgur [7] with no

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Presented at the XXVth International Conference on High Energy Physics, Singapore, August 2-8, 1990 background term. Unfortunately, this model makes no prediction for the $\eta\pi^-$ spectrum.

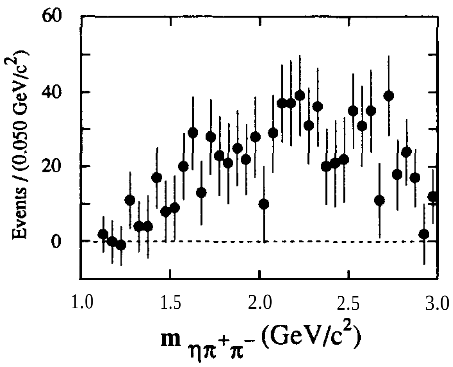

Fig. 2 The $\eta\pi\pi$ mass spectrum from reaction (1) above the η'.

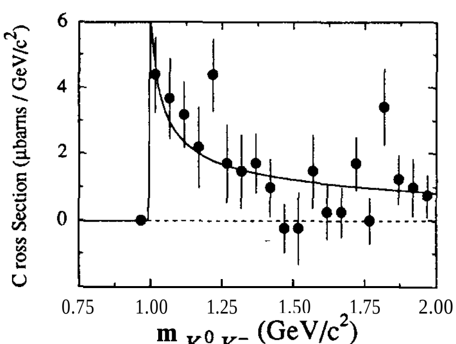

Fig.3 The $K\bar{K}$ model fit to data from reaction (4).

The $\bar{K}^*K^*$ system in reaction (2) has been studied both in neutral ($K^-\pi^+K^+\pi^-$) and charged ($K^0_S\pi^-K^0_S\pi^+$) decay modes. The Dalitz plots (not shown) for both reactions show clear evidence of correlated double vector (*VV*) $\bar{K}^*(890)K^*(890)$ production, and the background subtracted cross sections after all corrections are consistent with equality, as expected; $\sigma_{tot}(\bar{K}^*K^*)$ is 3.4±0.2 μb for the former, and 3.7±1.0 μb for the latter charge configuration. The invariant $\bar{K}^*K^*$ mass distributions for both charge states are also quite similar, fig.4 shows the neutral K* spectrum. A sharp enhancement occurs in the region just above threshold. The distribution of the Gottfried-Jackson angle of the VV decay is suggestive of a resonance below ~2.2 GeV/c^2 and the result of an S-wave Breit-Wigner fit to this region with mass 1950±15 MeV/c^2 and width 250±50 MeV/c^2 is shown in fig. 4. This threshold structure seems to be a consistent feature of the $\bar{K}^*K^*$ final state, essentially independent of the production mechanism. For example, these mass distributions are very similar to those produced via radiative J/ψ decay [8], $\gamma\gamma$ in e^+e^- collisions [9], and central production in pp interactions [10].

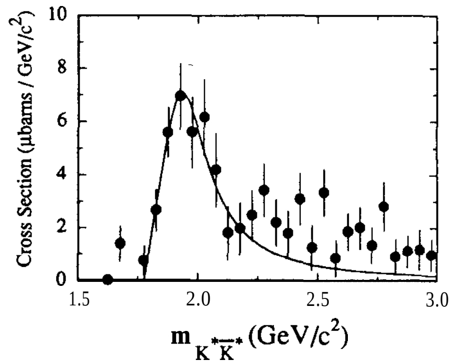

Fig. 4 The neutral $\bar{K}^*K^*$ spectrum from reaction (2).

An angular analysis of these states has been performed using the method described by Trueman [11], and Chang and Nelson [12]. This method uses two projected angular distributions; the dihedral (azimuthal) angle, χ, between the vector decay planes in the VV rest frame; and the helicity (polar) angle, θ, of the K in the rest frame of the K* relative to the vector momentum in the VV rest frame.

Experimentally, the most important feature of these distributions is that the $J^{PC}=0^{-+}$ wave has a distinct structure which should be observable, if dominant, whereas other waves, even if produced with little background, would be much harder to disentangle, particularly since, for many J^{PC} states, there is more than one (L,S) combination.

The angular distributions for the $\bar{K}^*K^*$ system of reaction (2) are essentially flat, inconsistent with a dominant 0^{-+}. Dominant 2^{++}, 2^{-+} or 1^{+-} waves are somewhat favoured, but the distributions are also consistent with other waves or combinations of waves. The angular distributions seen in central production in pp interactions are also flat. In contrast, the results from e^+e^- show structure with negative parity, which appears to be consistent with a strong 0^{-+} component. This is supported by results from a likelihood ratio test which also favours a strong 0^{-+} component [8].

The $\phi\phi$ system in reaction (3) has been studied in the $K^-K^+K^-K^+$ decay mode. The Dalitz plot (not shown) shows clear VV production of $\phi\phi$. The invariant $\phi\phi$ mass distribution, shown in fig. 5, has an enhancement in the region above threshold, but this threshold structure seems to be less sharp than that produced via radiative J&decay [13]. The distributions from forward π^-p collisions [14] and central production in pp collisions [15], are quite similar, and appear to lie between the K-p and e^+e^- results in terms of the sharpness of the structures.

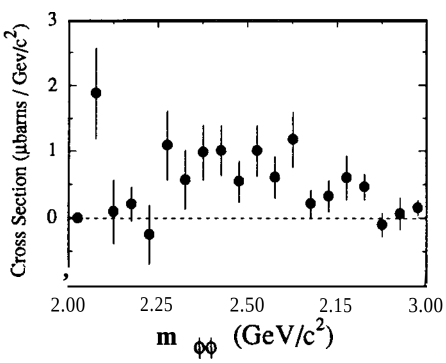

Fig. 5 The φφ spectrum from reaction (3).

The angular distributions for reaction (3) are also essentially flat. They are consistent with a pure 2^{++} state (among other hypotheses), but are again clearly inconsistent with a dominant 0^{-+}. The angular distributions seen in central production in pp collisions are also flat, In contrast, the results for-the threshold (X(2.2)) region from e^+e^-, show clear structure with negative parity, which appears to be consistent with a strong 0^{-+} component. This is supported by its similarity to the structure observed in the region of the η_c which is known to be a 0^{-+} object.

In summary, the *VV* systems discussed here all show enhancements in mass near threshold. The shapes of these enhancements are quite similar, independent of production mode, for the $\bar{K}^*K^*$ systems but typically show larger differences in the φφ system. However the primary differences between production modes are observed in the angular distributions, Systems produced via radiative decay from the J/ψ show strong 0^{-+} components whereas the hadronic production modes do not. The hadronic modes are all consistent with a strong 2^{++} component but in only one case [14] has this dominance been conclusively demonstrated. In the other channels studied to date, a combination of waves would also suffice to explain the data

Conclusion

Important questions remain about states with hidden strangeness. With a rather clear picture of the low mass $q\bar{q}$ systems emerging, it is becoming increasingly clear that several states seen primarily in other production modes have no convenient home in the $q\bar{q}$ sector. For example, low mass 0^{++} systems have been confusing for many years, and it now Seems quite clear that there are "too **many"** such states. The E/ι and θ(1720) regions contain many puzzles, and there are intriguing structures in the VV systems, particularly in the threshold region, which are not understood. These observations may point to the existence of meson physics beyond the quark model. We hope that the continuing analyses of data from LASS will be helpful in understanding the nature of these new spectroscopies.

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