CHARGED K* PRODUCTION IN e^+e^- ANNIHILATIONS AT 29 GeV

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We report a measurement of the charged K*(892) production in e^+e^- annihilations at 29 GeV center-of-mass energy The 300 pb^{-1} data sample used for this analysis is obtained with the High Resolution Spectrometer at the SLAC storage ring PEP The total mean multiplicity is measured to be $\langle n_{K^*(892)} \rangle = 0\,62 \pm 0\,045 \pm 0\,04$ per hadronic event Evidence is also given for the production of a charged $K_2^*(1430)$ tensor meson

It is generally believed that a better understanding of the strong binding forces may become available through the studies of hadron production in high energy annihilations Several models have been able to provide successful parameterizations of the non-perturbative production mechanisms [1-3] The precise measurement of the production of massive mesons is of special interest to these developing models, since such mesons are created early in the fragmentation chain, and therefore carry direct information with regard to the fundamental production processes The lighter mesons are often decay products of the heavier particles

In this letter we report a precise measurement of the inclusive production of the charged K*(892) through its $K_s^0\pi^\pm$ decay mode, where the K_s^0 is identified by its weak $\pi^+\pi^-$ decay An evidence for the production of charged $K_2^*(1430)$ is also presented in the same decay channel We have previously reported measurements of the neutral states of these mesons [4,5]

The data sample used for this analysis corresponds to an integrated luminosity of 300 pb^{-1} collected with

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the High Resolution Spectrometer (HRS) at the 29 GeV e^+e^- storage ring PEP The HRS detector is equipped with a tracking device consisting of 17 cylindrical drift layers, as well as lead-scintillator shower counters. The detector is contained in a 16 2 kG solenoidal magnetic field which provides excellent momentum resolution for the charged tracks over 90% of the 4π solid angle A detailed description of the detector and the selection procedures for the hadronic events have been reported elsewhere [6]

This analysis used a clean sample of hadronic events with high quality tracks Each event was required to have a total sum of visible charged and neutral energy of at least 10 GeV Events with fewer than 5 reconstructed charged tracks were rejected In all remaining events, tracks were removed from this analysis if they failed to register in more than 60% of the drift chamber layers available to them, or if they formed an angle (θ) with respect to the beam direction with $|\cos\theta| > 0\ 9$ Finally, it was required that the momentum component transverse to the beam of every track exceed 0 125 GeV/c

The selection of the K^0_s candidates has already been described in detail [7] Briefly, the long-lived $K^0_s \to \pi^+\pi^-$ decays were identified by requiring that the two decay tracks intersect in a plane perpendicular to the beam axis at a minimum radial distance of 0 5 cm measured from the interaction point The candidates were fitted to a three-dimensional secondary vertex and events with $\chi^2 < 10$ were accepted This selection produced a narrow peak in the $\pi^+\pi^-$ mass spectra (m), above a low background [7] All combinations with $|m - 0\ 4977| < 0\ 015$ GeV were assigned the K^0_s mass of 0 4977 GeV [#1]

The production of the K*(892) was searched for by combining the K^0_s candidates with the charged tracks assumed to be pions The combinatorial background was reduced by requiring that (a) the pion track originate from the interaction point, (b) the cosine of the angle between the charged track and the K^0_s direction of flight be greater than 0 6, and (c) $\cos\theta^* > -0\ 7$ where θ^* is the pion decay angle in the $K^0_s\pi^\pm$ rest frame This cut reduces the high combinatorial background observed for decays with the pion produced backwards in the $K^0_s\pi$ rest frame

[#1] All particle parameters used in this analysis are taken from ref [8]

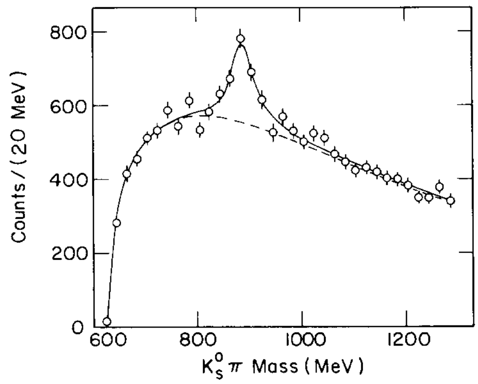

Fig 1 Invariant mass spectrum for $K^0_s\pi^\pm$ combinations The solid curve is the result of a fit which includes a Breit–Wigner and a smooth background The dashed curve represents the background

Since the acceptance is poor for low momentum mesons, only combinations with fractional momentum $x > 0\ 05$ ($x = p/p_{\rm beam}$) were accepted.

In the $K^0_s\pi$ invariant mass plot of fig 1, a clear enhancement, corresponding to the $K^{*\pm}(892)$ is evident This mass spectrum was fitted with contributions from a relativistic Breit–Wigner shape, with the mass and width fixed to the known $K^{*\pm}(892)$ values [#2], and a smooth curve for the background [#3] This fit gives 970 ± 67 events in the $K^{*\pm}(892)$ peak If the mass and width are left free in the fit, values of $893 \pm 2\ 5$ MeV for the mass and 47 ± 7 MeV for the width are found

The detection efficiencies were calculated by Monte Carlo techniques with complete detector simulation The observed number of $K^{*\pm}(892)$ events, after corrections for the efficiency and the known branching ratios of its decay chain, gave $0\ 56 \pm 0\ 04 \pm 0\ 035$ $K^{*\pm}(892)$ per hadronic event for fractional momentum $x > 0.05$ This result may be compared with multiplicities of 0 62 predicted by the Lund string model [1] and 0 45 given by the Webber cluster model [2] for $x > 0\ 05$ An extrapolation to the full x-range, using the shape of the momentum spectrum given by the Lund model, yields a total multiplicity of $0\ 62 \pm 0\ 045 \pm 0\ 04$ $K^{*\pm}(892)$ per

[#2] The detector mass resolution of 10 MeV was added in quadrature to the natural $K^{*\pm}(892)$ width This gave the almost negligible effect of changing the 51 1 MeV natural width to 52 1 MeV

[#3] We used the function $\alpha_0(m - m_0)^{\alpha_1}\exp(\alpha_2 m + \alpha_3 m^2)$, where the α_n are free parameters and m_0 is the $K^0_s\pi$ mass threshold

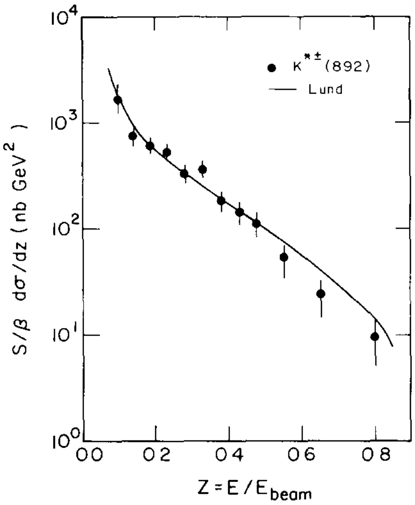

Fig 2 Scaling cross sections for the $K^{*\pm}$ (892) production The solid curve is the prediction of the Lund string model

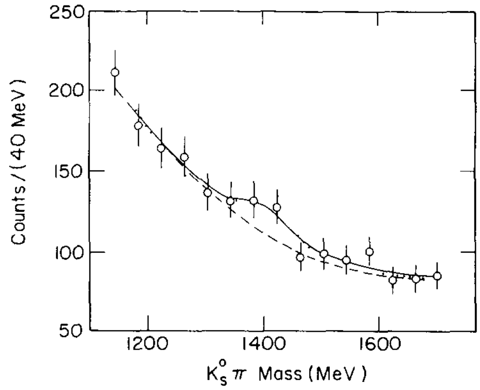

Fig 3 Invariant mass spectrum for $K^0_S\pi^\pm$ combinations, in the region of the $K_2^{*\pm}$ (1430) mass The solid curve is the result of a fit which includes a Breit–Wigner and a smooth background The dashed curve represents the background, and the dotted curve is the 90% confidence level upper limit fit described in the text

hadronic event. This result is in reasonable agreement with the JADE collaboration measurement of 0.87 ± 0.16 $K^{*\pm}(892)$ per hadronic event at $\sqrt{s}=35$ GeV [9]

The fragmentation function was measured by repeating the analysis for different x intervals The measured scaling cross section, $(s/\beta)\mathrm{d}\sigma/\mathrm{d}z$, is shown in fig 2 as a function of fractional energy z ($z=E/E_{beam}$) For this analysis a value of $\sqrt{s}=28.3$ GeV is used to correct for the initial state radiation The prediction of the Lund model, shown in this figure, agrees well with the data The relevant parameters of the Lund model were set to reproduce our previous measurements of the neutral strange mesons [#4]

A study of the pion decay angle in the $K^*(892)$ rest frame (θ^*) shows a uniform distribution for the $\cos\theta^*$, and so, no evidence for a spin alignment is observed [#5] This is in agreement with the Lund and the Webber models predictions Quantitatively, the acceptance corrected ratio of the number of events with $|\cos\theta^*|<0.5$ and with $|\cos\theta^*|>0.5$ is measured to be 1.1 ± 0.2, consistent with a flat distribution

A search for the $K_2^{*\pm}(1430)$ production in the $K^0_S\pi^\pm$ channel was performed using an almost identical analysis, except that the minimum value of the cosine of the angle between decay particles was reduced to -0.5 This allows larger angles between the decay products, which is more likely for a decay with a large available phase space Fig 3 shows the $K^0_S\pi^\pm$ invariant mass plot in the $K_2^{*\pm}$ (1430) region for $0.2<x<0.7$ This selection removes the large background which dominates the region with $x<0.2$, and rejects the $x>0.7$ region which contains few events The solid curve in fig 3 is the result of a fit with a relativistic Breit–Wigner shape (with fixed mass and width) and a smooth background some indication of a $K_2^{*\pm}$(1430) peak is seen, and we find 67 ± 31 events in the signal An identical analysis was performed on a sample of the Lund Monte Carlo [11] generated events which were put through the full detector simulation and did not contain the $K_2^{*\pm}$(1430) resonance No enhancement at ~1430 MeV was observed, and the shape of the mass spectrum was well described by the smooth background of fig 3 (dashed curve) The signal in fig 3 corresponds to a multiplicity of $0.04\pm0.02\pm0.01$ $K_2^{*\pm}$(1430) per hadronic event for the fractional momentum interval $0.2<x<0.7$, which is in good agreement with the multiplicity of 0.038 per hadronic event given by the Webber cluster model for the same x-interval [#6] Using the shape of the fragmentation function pre-

[#4] See ref [5] for details

[#5] Evidence has been presented for alignment of the ρ^0 meson produced in neutrino interactions See e g ref [10]

[#6] Comparison with the Lund model is not possible since this model does not include the production of the tensor mesons dicted by this model, the corresponding total mean multiplicity is 0 09±0 04±0 02 $K_2^{*\pm}(1430)$ per hadronic event This value agrees with our previous measurement of the rate for the neutral $K_2^*(1430)$ production [4] of 0 14±0 08 per hadronic event

Since the $K_2^{*\pm}(1430)$ signal is not statistically significant, an upper limit to the multiplicity is also calculated The dotted curve in fig. 3 represents the 90% confidence level upper limit fit, which corresponds to an increase of 2 69 in the χ^2 when a resonance contribution is imposed on a smooth background assumption This led to an upper limit of 0 10 $K_2^{*\pm}(1430)$ per hadronic event on the 90% confidence level for the interval $0\ 2<x<0\ 7$. The extrapolated upper limit multiplicity using the shape of the momentum spectrum given by the Webber model is 0 21 per hadronic event for all x

In summary, the production of charged K*(892) has been precisely measured, and the results are in agreement with the Lund model predictions Our study of the CM decay angle distribution is consistent with the absence of any K*(892) spin alignment We also find evidence for the production of $K_2^{*\pm}(1430)$ in e^+e^- annihilations at 29 GeV CM energy, with a multiplicity in accord with the prediction of the Webber cluster model

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