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EVIDENCE FOR A $(K\pi\pi)$ RESONANCE WITH $T_Z = \pm 3/2$ AT 1270 MeV

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The Saclay 81cm hydrogen bubble chamber was exposed to a separated beam of antiprotons from the CERN proton synchrotron. A total of 120,000 photographs were taken containing 8×10^5 antiprotons of 3.0 GeV/c momentum. We consider events in which a K_1^o decay was associated with a 4-prong interaction. From two independent scans, the overall efficiency for these types of event is estimated to be 97 o/o. Approximately 550 events were measured, and their geometry and kinematics have been computed using the THRESH-GRIND system of programmes. Less than 10 o/o of the events did not give a good geometrical reconstruction after several remeasurements, and about 60 events were excluded as having more than one missing neutral particle. When the fitting programme gave several interpretations, ionization measurements were made, thus reducing the number of ambiguous events to 17 o/o. Here, we discuss evidence for a peak in the $(K\pi\pi)$ mass distribution from 183 well-identified events of the types

$$\bar{p}\, p \dashrightarrow K_1^o\, K^{\pm}\, \pi^{\mp}\, \pi^+\, \pi^-\, \pi^o .$$

In these 183 events we observe 110 ± 20 K^*, 90 ± 36 ρ and 45 ± 10 ω(1). The presence of a charged K allows T_Z to be known unambiguously for all particles. The $(K\pi\pi)$ invariant mass distributions are shown in Fig. 1, there being 8 possible combinations with $T_Z = \pm 1/2$ and 4 with $T_Z = \pm 3/2$; the curves indicate Lorentz invariant phase space. A deviation from phase space (3 standard deviations) exists in the mass region 1200 - 1300 MeV for $T_Z = \pm 3/2$. We have

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then selected those events which have a $T_Z = \pm 1/2$ $(K\pi)$ mass (6 possible combinations) in the K^*_{888} region (830 - 945 MeV), and studied the $(K^*\pi)$ mass distributions, shown as the shaded histograms in Fig. 1; the superposed curve in this case corresponds to the $K^*\pi$ phase space. An enhancement (4 standard deviations) at about 1270 MeV is then apparent for the $T = \pm 3/2$ combinations; in more detail, the two systems $(K^\pm \pi^\mp \pi^\mp, K^o \pi^+ \pi^+, \overline{K^o} \pi^- \pi^-)$ and $(K^\pm \pi^o \pi^\pm, K^o \pi^o \pi^-, \overline{K^o} \pi^o \pi^+)$ give peaks above phase space which are in the ratio of (2.3 ± 1.4): 1 a value compatible with the ratio of 2 : 1 expected from the Clebsch-Gordon coefficients for decay of the K^*. It is more difficult to draw any conclusions for $T_Z = \pm 1/2$ because of the larger background (there are 2 $(K^*\pi)$ combinations with $T_Z = \pm 1/2$ compared with one for $T_Z = \pm 3/2$). The ambiguous events were added to the $K^*\pi$ mass distributions in various ways and no significant changes were observed. We have also studied the effects of ω^o and ρ production on the $K^*\pi$ spectrum by generating false events and have found good agreement with phase space.

In order to look for the possible decay mode$(K\ \rho)$of this state we have plotted the $(K\ \rho)$ $T_Z = \pm 3/2$ mass distribution, shown as a shaded histogram in Fig. 2a. This also provides some evidence for an excess of events above phase space in the same mass region. Because of two-body phase space factors, the $(K\ \rho)$ decay mode is less likely than the $(K^*\pi)$ by a factor of approximately 3. The larger histogram in Fig. 2a is the sum of $(K^*\ \pi)$ and $(K\ \rho)$ with $T_Z = \pm 3/2$, and it shows a four standard deviation peak at about 1270 MeV, which represents (25 ± 8) o/o production of this state per event.

To determine the mass and width of this peak, we show in Fig. 2b a Gaussian ideogram of mass for $(K^*\pi)$ with $T_Z = \pm 3/2$, calculated using estimated errors of 14 MeV on the masses. Lorentz invariant phase space modified by a Breit-Wigner curve was fitted to this ideogram, and from the best fit we obtain a mass of (1270 ± 20) MeV and a width (60 ± 30) MeV.

Fig. 3 shows Dalitz plots for the decay of $T_Z = \pm 3/2$ $(K\pi\pi)$ combinations with mass in the interval 1240 - 1300 MeV. Combinations of the type $K\ \pi^\pm\ \pi^\pm$ (Fig. 3a) are reflected about 45^o and appear twice since $(K\pi)$ $T_Z = \pm 1/2$ combinations can be formed with both pions. A concentration of events in the K^* bands is apparent. For the $(K\ \pi^\pm\ \pi^o)$ combinations, only the $(K\ \pi^o)$ has $T_Z = \pm 1/2$;

however, ρ can also be produced (Fig. 3b). Similar plots for $(K\pi\pi)$ masses in neighbouring control regions are more uniformly populated, as are those for $T_Z = \pm 1/2$ $(K\pi\pi)$ masses in the interval 1240 - 1300 MeV.

If we interpret this state of isotopic spin 3/2 (5/2 being excluded by the $K^* \pi$ decay mode) as a member of a SU_3 representation, then the branching ratio for its decay into $(K^* \pi)$ versus $(K \rho)$ would be unity[2], which is consistent with our data after corrections for two-body phase space have been applied. Wangler et al[3] and Armenteros et al[4] have reported evidence for $(K\pi\pi)$ resonances in $T_Z = \pm 1/2$ systems at 1175 MeV and 1230 MeV, respectively. The $(K\pi\pi)$ state of ref.(4) decays predominantly into $(K \rho)$ but no evidence is presented in either case for a $(K^* \pi)$ decay mode.

Another possible interpretation of this peak could be the presence of a final state interaction $K^* \pi \rightleftharpoons K \rho$ via the exchange of a pion, which results in a peak in the $K^* \pi$ and $K \rho$ masses at about 1270 MeV[5]. However, production with isotopic spin 1/2 would then be favoured relative to 3/2, which is not observed.

Acknowledgment

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Figure Captions

Fig. 1 (a) Mass distributions for $(K\pi\pi)$ combinations with $T_Z = \pm 1/2$. The shaded histogram shows those combinations which contain a K^*_{888}.

(b) The same as (a) for $T_Z = \pm 3/2$ combinations.

Fig. 2 (a) Mass distributions for $(K^*\pi)$ and $(K\,\rho)$ combinations with $T_Z = \pm 3/2$. The shaded histogram shows $(K\,\rho)$ combinations only.

(b) Ideogram of masses for $(K^*\pi)$ combinations with $T_Z = \pm 3/2$. The curve indicates phase space modified with a Breit-Wigner resonance curve with mass 1270 MeV and width 60 MeV.

Fig. 3 Dalitz plots for $T_Z = \pm 3/2$ $(K\pi\pi)$ combinations with mass in the interval 1240 - 1300 MeV.

(a) for $(K\,\pi^{\pm}\,\pi^{\pm})$, reflected about 45°

(b) for $(K\,\pi^{\pm}\,\pi^{0})$.

FIG. 1

$K_1^0 K^{\pm} \pi^{\mp} \pi^+ \pi^- \pi^0$

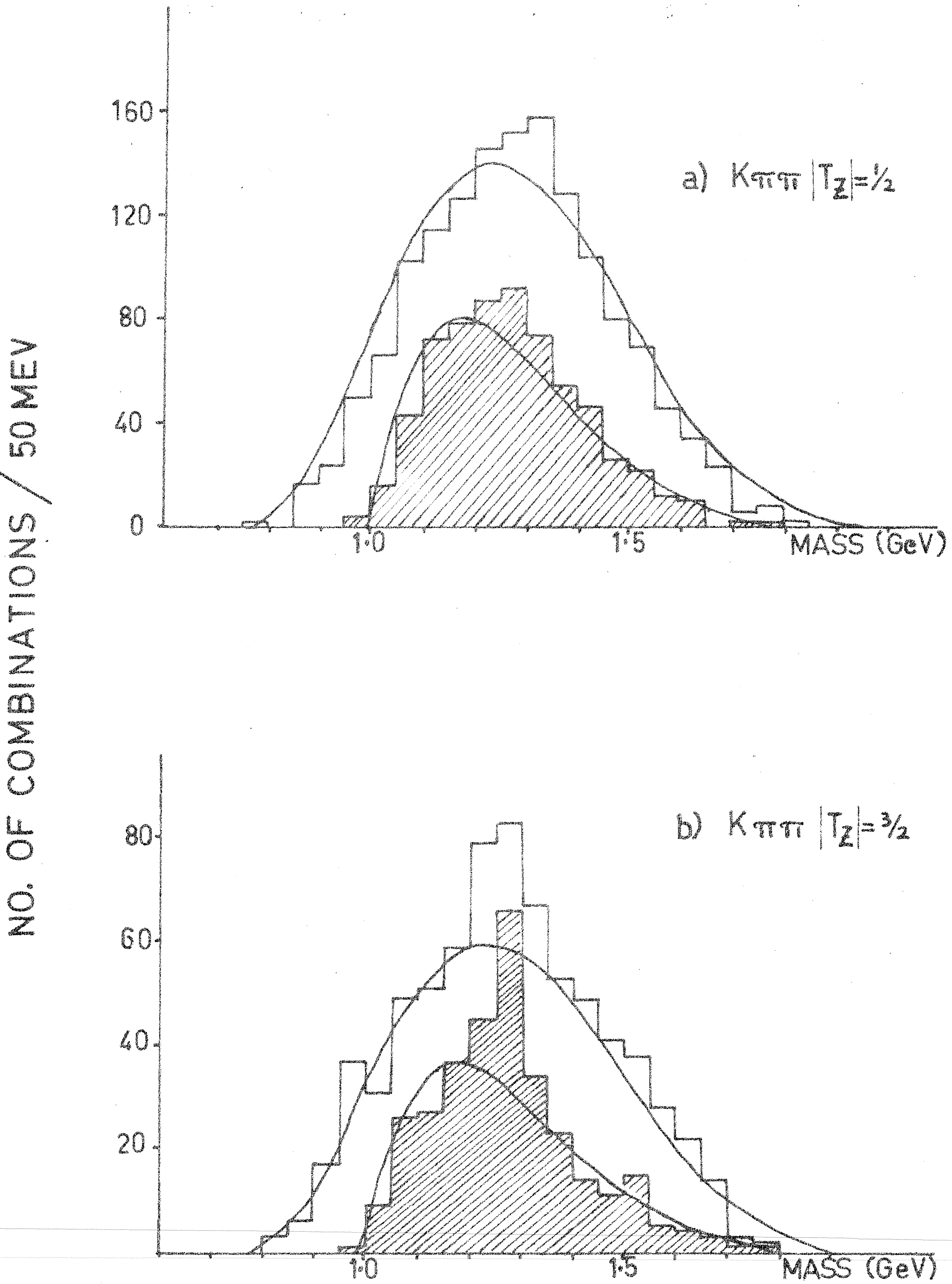

FIG. 2

$K_1^0 K^{\pm} \pi^{\mp} \pi^+ \pi^- \pi^0$

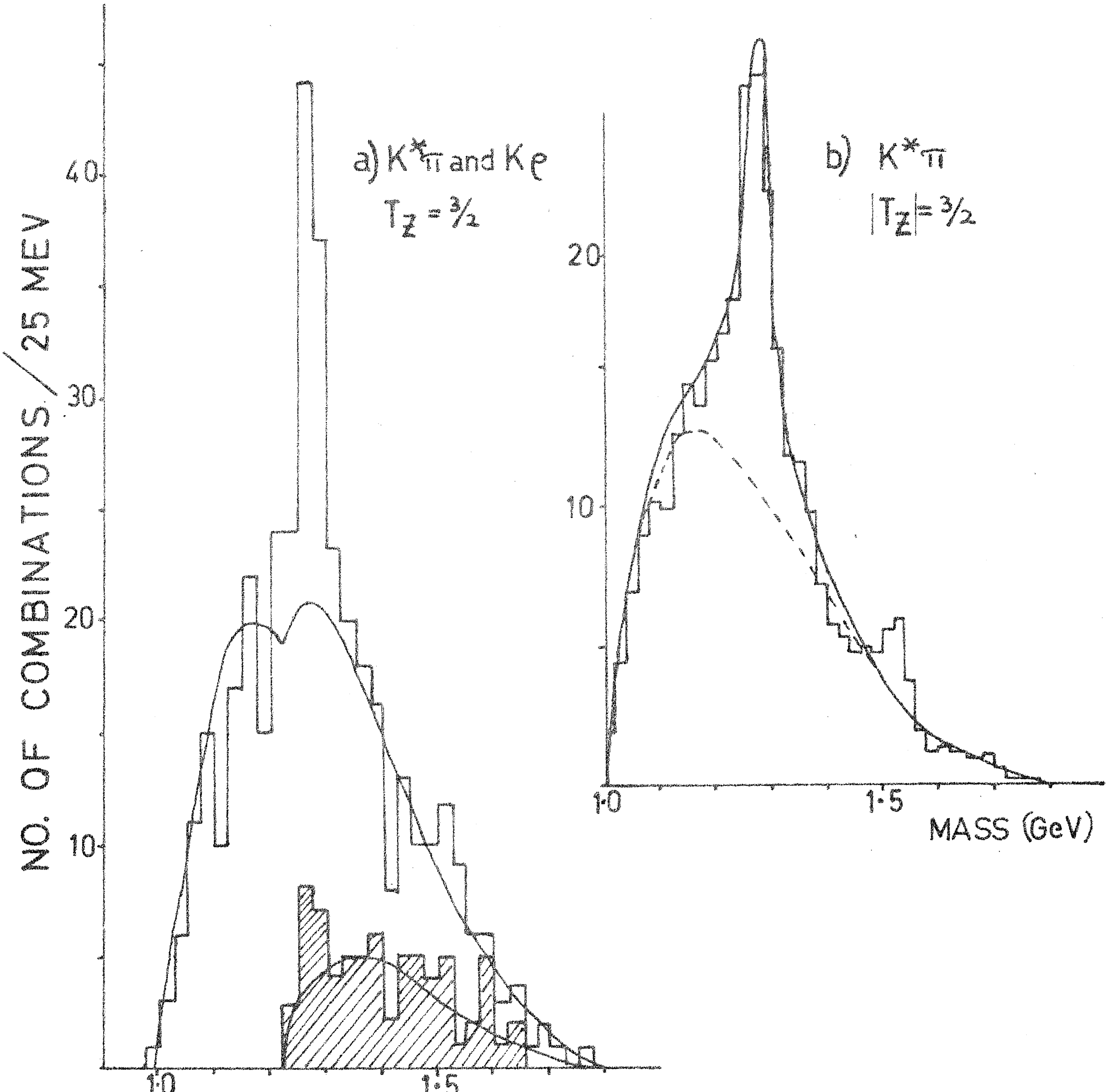

FIG. 3

$K_1^0 K^{\pm} \pi^{\mp} \pi^{+} \pi^{-} \pi^{0}$