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NEW RESULTS ON THE E(1420)/IOTA(1460) MESON IN HADROPRODUCTION

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NEW RESULTS ON THE E(1420)/IOTA(1460) MESON IN HADROPRODUCTION

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A mini-review, with emphasis on new results, is given on the status of the hadroproduced E(1420)/iota(1460) meson in the decay channels $\eta\pi\pi$ and $K\bar{K}\pi$. The BNL data at twice the statistics of the previously published event sample show clearly a $J^{PG} = 0^{-+}$ $\delta(980)\pi$ state with a phase motion characteristic of a resonance.

This review covers recent and hitherto unannounced results from the BNL experiment[1] on the $K\bar{K}\pi$ state in the 1.4 GeV region. In addition, the results from a KEK experiment on the $\eta\pi\pi$ decay channel and those of CERN OMEGA experiment on $\eta\pi\pi$ and $K\bar{K}\pi$ channels are presented for comparison.

There exists in the literature a number of reviews[2,3] on the experimental status of the hadroproduced E(1420)/iota (1450) coupling to $\delta(980)\pi$ and $K^*\bar{K}$. The present review concentrates on new results from the BNL experiment on the reaction

$$\pi^- p \to K^+ K_s \pi^- n \qquad (1)$$

at 8 GeV/c. The data from their 1983 run have been previously analyzed using the isobar-model techniques of the Dalitz-plot (two-dimensional fits)[4] and the full partial waves (5-dimensional fits).[5] Additional new data from the 1985 run has now been added to the old data sample and a partial-wave analysis was performed on the combined data. Figure 1 shows the $K\bar{K}\pi$ mass spectrum with ≈4,000 E/iota events in the peak, representing twice the statistics of of their previous data for $-t < 1.0$ GeV^2. A fit with two simple Breit-Wigner forms for the peaks D(1285)/η_T(1275) and E(1420)/iota(1460) over a polynomial background gives: $M(D) = (1285) \pm 4)$ MeV, $\Gamma(D) = (22 \pm 5)$ MeV and $M(E) = (1421 \pm 3)$MeV, $\Gamma(E) = (70 \pm 8)$ MeV. The E/iota tends to be produced away from the forward region; the subsample with $0.2 < -t < 1.0$GeV^2 shows an E/iota peak on a much-reduced background (see the shaded histogram, Fig. 1).

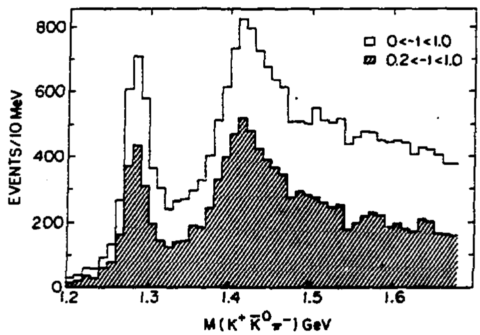

Figure 1: The $K^+\bar{K}^0\pi^-$ mass spectrum for combined '83 and '85 data with $0 < -t < 1.0$ GeV^2. The shaded histogram for events with $0.2 < -t < 1.0$ GeV^2.

The results of the BNL partial-wave analysis on the combined data are given in Figs. 2 and 3. This analysis allowed for the first time an arbitrary degree of coherence between the waves 0^{-+} (δ) and 0^{-+} (K^*). The best fit (preliminary) requires a nearly complete incoherence between the two waves, indicating perhaps different Regge exchanges for them (see Fig. 2c). This would indicate that the $0^{-+}(\delta)$ and $0^{-+}(K^*)$ states are not two different decay modes of a same object but rather two distinct states. As before, the 1^{++} wave shows a prominent peak of the D mass and a sharp rise in the E region.

A few relevant waves (preliminary) for the subsample of events with $0.2 < -t < 1.0$ GeV^2 are shown in Fig. 4. It is seen that the 0^{-+} (δ) wave executes a classic phase motion of a pure resonance with respect to a non-resonant 1^{++} 0^+ wave with a mass at ≈1400 MeV and a width at ≈60 MeV (dashed curves in Fig. 4).

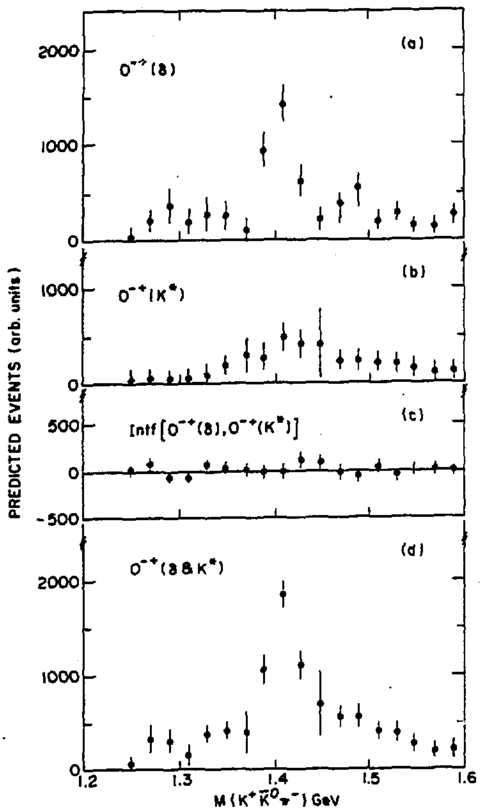

Figure 2: $M(K^+\bar{K}^0\pi^-)$ spectra for events fitted to the 0^{-+} wave from an isobar-model partial-wave analysis with spins 0 or 1 (preliminary).

It should be emphasized that the phase motion is now unambiguous, unlike the case when the events with $t < 0.2$ GeV^2 have been included in a previous analysis (Ref. 5).

These BNL results are generally confirmed by the KEK results[6] on the same reaction as that of the BNL experiment at the same energy. The KEK data have so far been partial-wave analyzed on only the decay channel $\eta\pi^+\pi^-$, and their partial-wave decomposition is given in Fig. 5. Three peaks are observed; I = 0, $1^{++}(\delta)$ and I = 0, $0^{-+}(\delta)$ in the D region, and I = 0, $0^{-+}(\delta)$ at the E mass [m = (1420 ± 5) MeV and Γ = (31 ± 7) MeV]. It should be noted that the $0^{-+}(\delta)$ state in the D region, the η_P (1275) first observed by N. Stanton, et al.[7], is not as prominent in the the BNL data. However, all three peaks show a rapid phase motion with respect to a non-resonant I = 1, $1^{--}(\rho)$ wave (not shown).

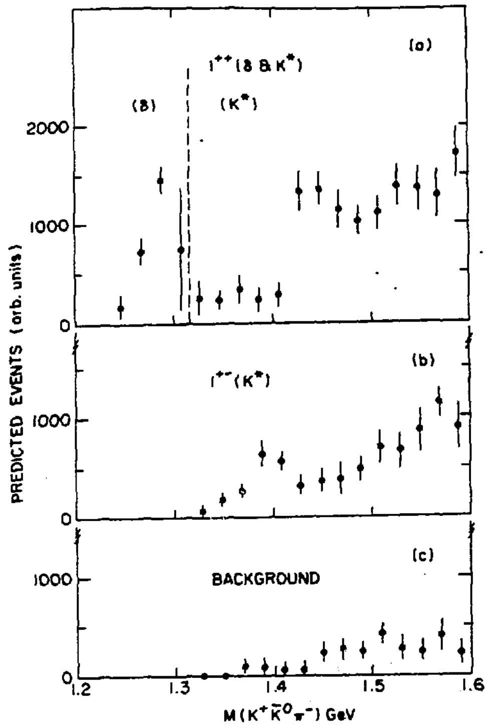

Figure 3: $M(K^+\bar{K}^0\pi^-)$ spectra for events fitted to the partial-waves 1^{++} and 1^{+-} along with incoherent phase-space event. Below (Above) 1.32 GeV only the $\delta(K^*)$ isobar was used in the fit (adding δ to the fits above 1.32 GeV does not appreciably alter the results).

The data of the CERN OMEGA experiment,[8] on the other hand, seem to be at variance with those of the BNL and KEK data. The CERN experiment studied the $\eta\pi^+\pi^-$ and $K\bar{K}\pi$ systems produced centrally off (π^+/p) and p in the interactions (π^+/p)p at 85 GeV/c. In contrast to the BNL and KEK analyses, the CERN data have so far been subjected to only the Dalitz-plot analysis. The $\eta\pi^+\pi^-$ spectrum exhibits a peak in the 1^{++} wave at the D mass and a hint of a bump at the E mass, but no 0^{-+} peaks are observed at either masses (not shown). For the first time, the $K\bar{K}\pi$ channel has been Dalitz-plot analyzed as a function of the mass per 40 MeV in the E region. The results are shown in Fig. 6.

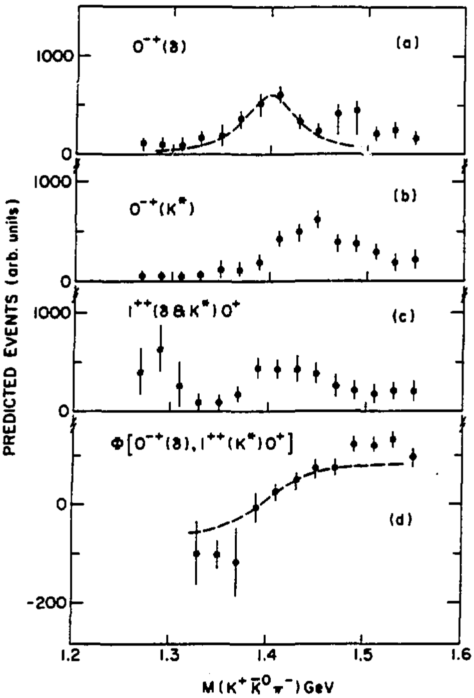

Figure 4: Results (Preliminary) of the partial-wave analysis on the subsample of events with $0.2 < -t < 1.0\ GeV^2$.
(a-c) $M(K^+\bar{K}^0\pi^-)$ spectra for events fitted to $0^{-+}(\delta)$, $0^{-+}(K^*)$ and $1^{++}(\delta\ \&\ K^*)0^+$ ($m = 0$, natural parity exchange).
(d) The phase motion (in degrees) of $0^{-+}(\delta)$ against $1^{++}(K^*)0^+$.

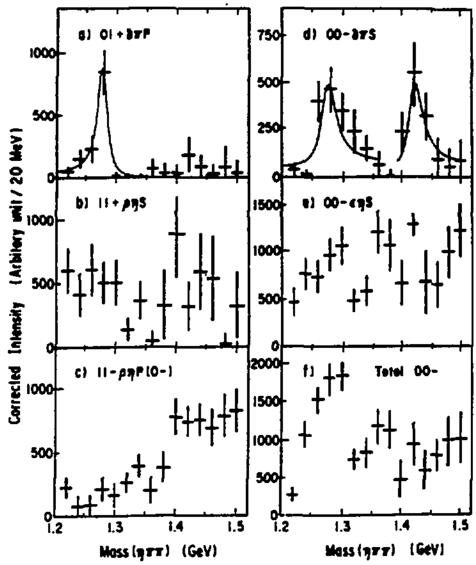

Figure 5: Partial-wave decomposition of the $M(\eta\pi^+\pi^-)$ spectrum for KEK data (Ref. 6). The first number on their partial-wave notations stands for the I-spin.

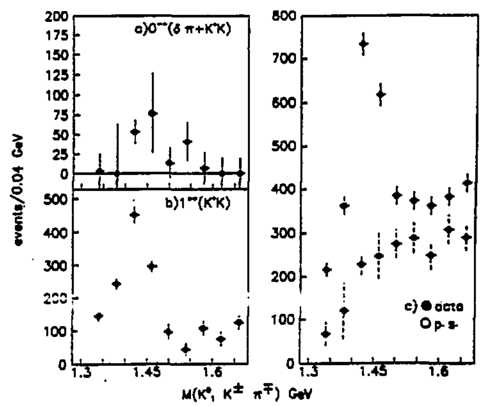

Figure 6: Dalitz-plot analysis of the CERN Ω-Spectrometer Data (Ref.8). (a) and (b) correspond to the waves 0^{-+} (δ & K^*) and $1^{++}(K^*)$. (c) $M(K\bar{K}\pi)$ spectrum (solid dots); incoherent phase-space background (open dots).

The E peak is still dominated by a 1^{++} (K^*) wave with a large incoherent phase-space background. In addition, the data now require a 0^{-+} (δ & K^*) wave at ≈10% level at the E peak.

For the moment, the situation with regard to the E(1420)/iota (1460) in hadroproduction seems uncertain. Both the BNL and KEK experiments find the 1^{++}D(1285)and the 0^{-+} E(1420)/iota (1460), both coupling to $\delta(980)\pi$. Coincidentally, both experiments rely on the same neutron-recoil reaction from π^-p interactions at 8 GeV/c. The 0^{-+} η_γ (1275) state, seen prominently in the KEK data, is seen much reduced in the $K\bar{K}\pi$ channels of the BNL data. The central-production experiment at the CERN OMEGA Spectrometer, on the other hand, finds the 1^{++} D(1285) in the $\delta\pi$ channel, but little 0^{-+} η_γ(1275) in either $\eta\pi\pi$ or $K\bar{K}\pi$ channels. In the E region, the CERN experiment sees a substantial 1^{++} (K^*) state with perhaps a ≈10% 0^{-+} (δ & K^*).

It is clear therefore that further independent analyses on a variety of additional hadron-induced reactions are necessary for clarification of the status of the η_γ (1275) and the E (1420)/iota (1460); these include partial-wave analyses of the $\eta\pi\pi$ and $\bar{K}K\pi$ channels at the SPS and Serpukhov energies,[9] the diffractive production of $K\bar{K}\pi$ systems at the ISR,[10] and the production of $\eta\pi\pi$ and $K\bar{K}\pi$ systems from K^-p interactions at BNL and KEK energies.

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