

8/26/86

CONF-860701--55

OG 918 - N/A

BNL--38622

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

DE87 002580

S.U. Chung

Brookhaven National Laboratory, Upton, NY 11973

Presented at the Parallel Session, Hadron Spectroscopy,

XXIII International Conference on High Energy Physics

Berkeley, California
July 16-23, 1986

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

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

S. U. Chung

Brookhaven National Laboratory
Upton, New York, USA 11973

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 $\pi\pi\pi$ and $KK\pi$. The BNL data at twice the statistics of the previously published event sample show clearly a $J^{PC} = 0^{-+} \delta(980)\pi$ state with a phase motion characteristic of a resonance.

This review covers recent and hitherto unannounced results from the BNL experiment on the $KK\pi$ state in the 1.4 GeV region. In addition, the results from a KEK experiment on the $\pi\pi\pi$ decay channel and those of CERN OMEGA experiment on $\pi\pi\pi$ and $KK\pi$ 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 $K^*\pi$. The present review concentrates on new results from the BNL experiment on the reaction

$$\pi^+p \rightarrow K^+K_s^0\pi^-n \quad (1)$$

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 $KK\pi$ mass spectrum with $\sim 4,000$ E/iota events in the peak, representing twice the statistics of of their previous data for $-t < 1.0$ GeV². A fit with two simple Breit-Wigner forms for the peaks D(1285)/ η_π (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 $0.2 < -t < 1.0$ GeV² shows an E/iota peak on a much-reduced background (see the shaded histogram, Fig. 1).

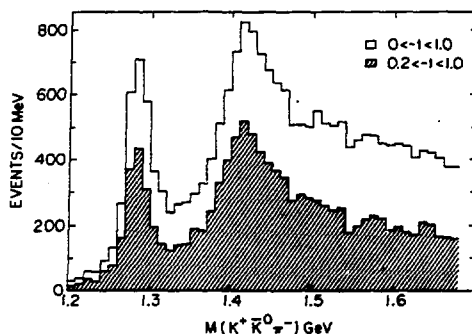


Figure 1: The $K^+K_s^0\pi^-$ mass spectrum for combined '83 and '85 data with $0 < -t < 1.0$ GeV². The shaded histogram for events with $0.2 < -t < 1.0$ GeV².

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 $0^{-+}(\delta)$ 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 $0.2 < -t < 1.0$ GeV² are shown in Fig. 4. It is seen that the $0^{-+}(\delta)$ 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).

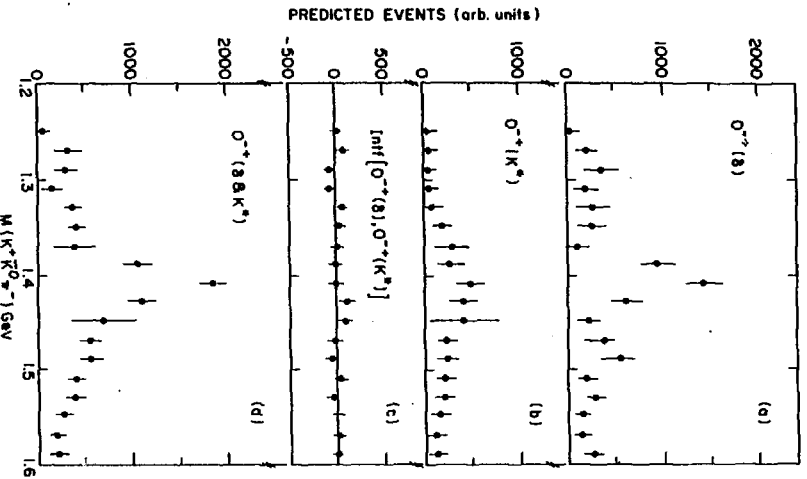


Figure 2: $M(K^+K^0\pi^-)$ spectra for events fitted to the O^{*+} wave from an isobar-model partial-wave analysis with spins 0 or 1 (preliminary).

It should be emphasized that the phase motion is now unambiguous, unlike the case when the events with $t < 0.2$ GeV² have been included in a previous analysis (Ref. 5).

These BNL results are generally confirmed by the KEK results 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 $\pi^+\pi^-$, and their partial-wave decomposition is given in Fig. 5. Three peaks are observed: $I = 0, 1^{++}(6)$ and $I = 0, 0^{-+}(6)$ in the D region, and $I = 0, 0^{-+}(6)$ at the E mass [$m = (1420 \pm 5)$ MeV, and $\Gamma = (31 \pm 7)$ MeV]. It should be noted that the $0^{-+}(6)$ state in the D region, the η (1275), first observed by N. Stanton, et al., is not as prominent in 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).

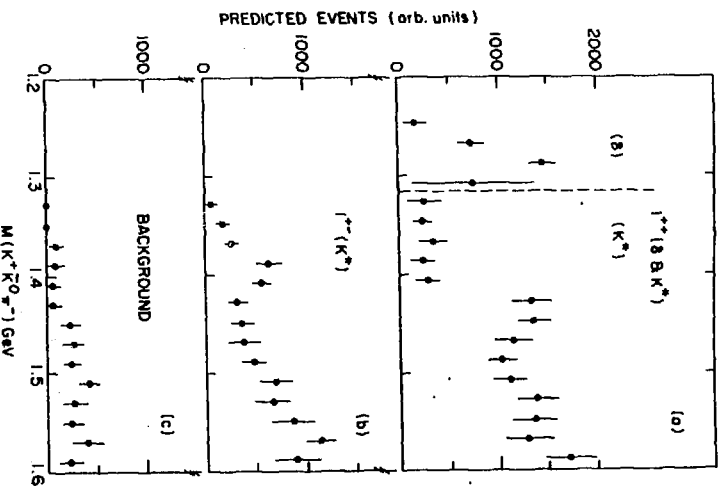


Figure 3: $M(K^+K^0\pi^-)$ spectra for events fitted to the partial-waves 1^{*+} and 1^{-+} along with incoherent phase-space event. Below (Above) 1.32 GeV only the $6(K^*)$ isobar was used in the fit (adding δ to the fits above 1.32 GeV does not appreciably alter the results).

The data of the CERN OMEGA experiment, on the other hand, seem to be at variance with those of the BNL and KEK data. The CERN experiment studied the $\pi^+\pi^-$ and $K\bar{K}\pi$ systems produced centrally off (π^+/p) and p in the interactions $(\pi^+/p)p$ 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 $\pi^+\pi^-$ 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.

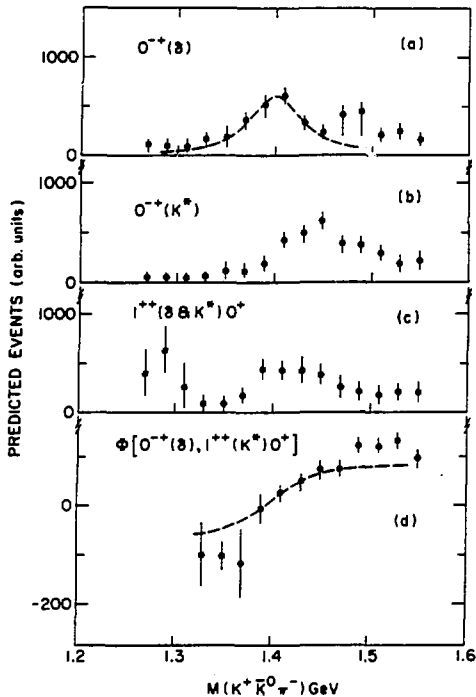


Figure 4: results (Preliminary) of the partial-wave analysis on the subsample of events with $0.2 < -t < 1.0 \text{ GeV}^2$. (a-c) $M(K^+K^0\pi^-)$ spectra for events fitted to $O^{-+}(\delta)$, $O^{-+}(K^*)$ and $1^{++}(\delta \& K^*)O^+$ ($m = 0$, natural parity exchange). (d) The phase motion (in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

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

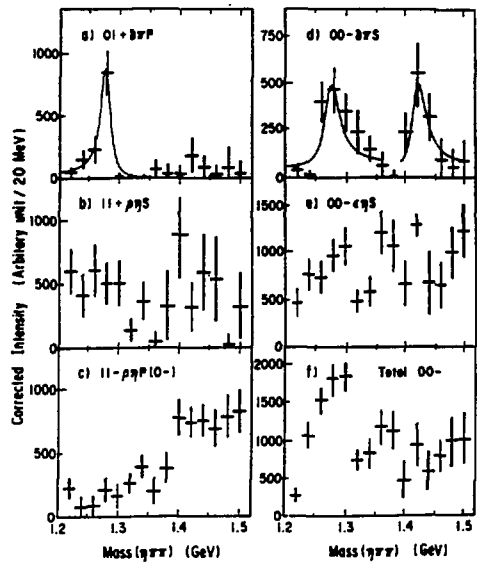
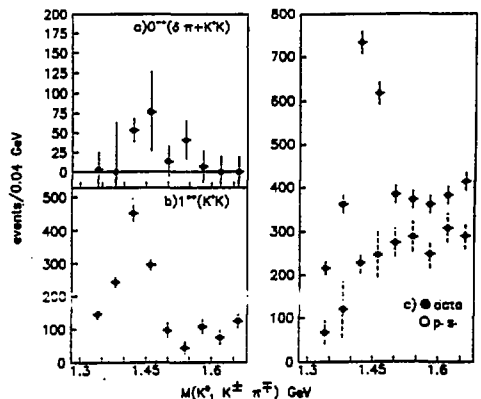


Figure 5: Partial-wave decomposition of the $M(\eta\pi^+\pi^-)$ spectrum for KEK data (Ref. 6). The first number on their partial-wave notations stands for the I-spin.



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 $\sim 10\%$ level at the E peak.

For the moment, the situation with regard to the $E(1420)/\iota(1460)$ in hadron-production 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 πp interactions at 8 GeV/c. The $0^{-+}\eta_\pi(1275)$ state, seen prominently in the KEK data, is seen much reduced in the $KK\pi$ 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 $0^{-+}\eta_\pi(1275)$ in either $\pi\pi\pi$ or $KK\pi$ channels. In the E region, the CERN experiment sees a substantial $1^{++}(K^*)$ state with perhaps a $\sim 10\%$ $0^{-+}(\delta \text{ \& } K^*)$.

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 $\eta_\pi(1275)$ and the $E(1420)/\iota(1460)$; these include partial-wave analyses of the $\pi\pi\pi$ and $KK\pi$ channels at the SPS and Serpukhov energies, the diffractive production of $KK\pi$ systems at the ISR,¹⁰ and the production of $\pi\pi\pi$ and $KK\pi$ systems from K^-p interactions at BNL and KEK energies.

Research supported by U.S. Department of Energy under Contract No. DE-AC02-76CH0016.

REFERENCES

1. AGS Experiment #771 with the BNL MPS: S.U. Chung, R. Fernow, H. Kirk, S.D. Protopopescu, D.P. Weygand, H. Willutzki (BNL); D. Boehnlein, J.H. Goldman, V. Hagopian, D. Reeves (Florida State); S. Blessing, R. Crittenden, A. Dzierba, T. Marshall, S. Teige, D. Zieminska (Indiana); Z. Bar-Yam, J. Dowd, W. Kern, H. Rudnicka (Southeastern Mass).
2. S.U. Chung, XV Int'l. Symp. on Multiparticle Dynamics, Lund, Sweden (1984), p. 186; S.U. Chung, XXII Int'l. Conf. on High Energy Physics, Leipzig, E. Germany (1984), Vol. II, p. 167; S.U. Chung, XII Int'l. Winter Meeting on Fundamental Physics, Santander, Spain (1984), p. 295; S.U. Chung, 1986 Aspen Winter Conf. on Particle Physics (BNL #38153) to be published.
3. S. Cooper, Rapporteur Talk, Int'l. Europhysics Conf. on High Energy Physics, Bari, Italy (1985), p. 947.
4. S. U. Chung et al., Phys. Rev. Lett. 55, 779 (1985).
5. Results of our partial-wave analysis on BNL data have been presented by: D. Zieminska, Int'l. Conf. on Hadron Spectroscopy-1985, U. of Maryland (1985), p. 27; J. Dowd, Int'l. Europhysics Conf. on High Energy Physics, Bari, Italy (1985), p. 318; S.U. Chung, 20th Rencontre de Moriond, Les Arcs, France (1985), p. 489; S. Protopopescu, Annual Meeting of the APS Div. of Particles and Fields, Eugene, Oregon (1985), p. 671.
6. A. Ando et al., KEK Preprint 85-15.
7. N. Stanton et al., Phys. Rev. Lett. 42, 346 (1979).
8. T.A. Armstrong et al., Phys. Lett. 146B, 273 (1984); U.V. Baillie et al., Int'l. Europhysics Conf. on High Energy Physics, Bari, Italy (1985), p. 314; T.A. Armstrong et al., Paper #7870, the 23rd Int'l. Conf. on HEP, Berkeley, CA (July 1986).
9. Th. Mouthuy, Int'l. Europhysics Conf. on High Energy Physics, Bari, Italy (1985), p. 320; S.I. Bitukov et al., Serpukhov Preprint EFVE85-19; see also Refs. 2 and 3.
10. P. Chauvat et al., Phys. Lett. 148B, 382 (1984).