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PHASE SHIFT ANALYSIS OF $K\bar{K}\pi$ SYSTEM IN THE D AND E/IOTA REGIONS

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We have performed a high-statistics experiment on the reaction $\pi^- p \to K^+ \bar{K}^0 \pi^- n$ at 8.0 Gev/c. A partial-wave analysis of the $K^+\bar{K}^0\pi^-$ system finds that the D(1285) is mostly a $J^{PG}=1^{++}$ state coupling predominantly to a $\delta\pi$ decay channel, while the E(1420) peak consists mostly of a $J^{PG}=0^{-+}$ wave with a substantial $\delta\pi$ decay mode. There is little evidence of a 1^{++} resonance at the E mass.

A $J^{PC}=0^{-+}$ state called the iota(1440) is considered to be a prime glueball candidate because it is produced prominently in J/ψ radiative decays[1] where C=+1 glueballs are expected to be copiously produced. However, this assertion rests on the premise that it is distinct from the E(1420) discovered earlier by Armenteros et al.[2] ($J^{PC}=0^{-+}$ or 1^{++}) and determined to be a 1^{++} state in a Dalitz-plot analysis in a later experiment by Dionisi et al.[3] Since the spin and parity analysis of the E(1420) was based on limited statistics, it is desirable that a partial wave analysis of the spin and parity content of the E region be performed on a large statistics sample.

Our study of the $K\bar{K}\pi$ system is based on more than 10 times the statistics of Dionisi et al., obtained in the reaction

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

at 8 GeV/c. The data come from our experiment performed with the Brookhaven Laboratory Multiparticle Spectrometer (MPS). The $K^+K_S\pi^-$ spectrum for reaction (1), shown in Fig. 1, contains a sample of approximately 16,000 events remaining after cuts on K_S mass, n mass, and $-t < 1.0$ GeV^2. It is dominated by peaks at the D(1285) and E(1420) masses. A fit to the spectrum with two simple Breit-Wigner functions and a polynomial background gives $m=1285 \pm 2$ MeV and $\Gamma=22 \pm 2$ MeV for the D(1285) and $m = 1421 \pm 2$ MeV and $\Gamma = 60 \pm 10$ MeV for the E(1420). The results of a Dalitz-plot analysis of this data and a description of the apparatus and trigger are reported in a recent publication.[4] Here we present results of the complete partial wave analysis of the same data.

The partial wave analysis was carried out in the context of the isobar model, i.e. the $K\bar{K}\pi$ final state was treated as a superposition of $\delta\pi$ and $K^*(890)\bar{K}$ quasi two body states. The amplitudes (J^{PG} J = spin, P = parity, G= G-parity) for each isobar were defined in terms of reflectivity states.[5]

It is seen that the 1^{++} wave (Fig. 2b) is dominant at the D(1285) mass, confirming that it is a 1^{++} state.[6] Although the $\delta\pi$ decay mode is definately dominant for the D, a considerable amount of $K^*\bar{K}$ decay mode can be accomodated interfering destructively with the mode.

The behavior of the 0^{-+} wave in the E(1420) region in Fig. 2a shows clearly that the E peak in our data is mostly in a 0^{-+} state. Analysis of the 0^{-+} state into $\delta\pi$ and $K^*\bar{K}$ decay modes (Fig. 3) indicates that the $\delta\pi$ mode is predominant, but that the $K^*\bar{K}$ decay mode is definitely required, with strong constructive interference between them, to describe the data adequately. The 1^{++} wave (Fig. 2b), which is mainly $K^*\bar{K}$ with little $\delta\pi$, exhibits a sharp rise with the onset of the $K^*\bar{K}$ threshold at 1.4 GeV and levels off above the E peak. Thus we conclude that the E(1420) is not a 1^{++} state.

In summary, we confirm that the D(1285) is largely a 1^{++} state[6] while we find that the E(1420) is predominately a 0^{-+} state, and both of them require a substantial $\delta\pi$ decay mode. The 1^{++} ($K^*\bar{K}$) wave does not show a resonant behavior at the E mass. Our results, therefore, contradict those of Dionisi et al.[3] and Armstrong et al.[7] who find that the E(1420) is a 1^{++} ($K^*\bar{K}$) state with no other waves required in the E region.

On the other hand our results are in agreement with those of J/ψ radiative decay,[1,8] with those of Baillon,[9] and with recent results of Ando et al.[10] so that the E(1420) and the iota(1440) may very well be the same 0^{-+} object. However, recently measured values of the mass of the iota in J/ψ radiative decay[8] are somewhat higher than those of the hadroproduced E(1420). If the iota(1440) is to be identified with the E(1420), it is unlikely to be a pure glueball and must be heavily mixed with a $q\bar{q}$ state because of its prominent production in a hadron-induced reaction such as ours.

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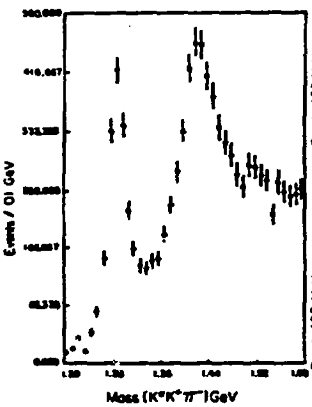

Fig. 1 $K^+K_s\,\pi^-$ spectrum

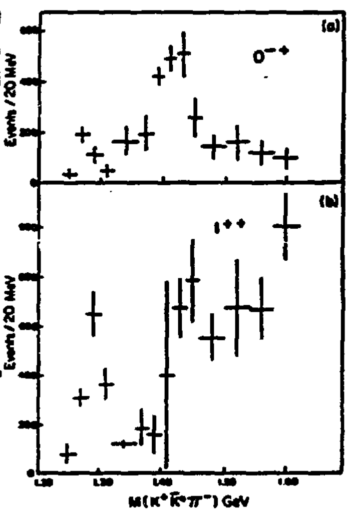

Fig. 2 Acceptance corrected spin-parity content of the ($K\bar{K}\,\pi$) system
a) J(PG) = 0(-+) wave with combined δπ and K^*K modes
b) J(PG) = 1(++) wave with combined δπ and K^*K modes

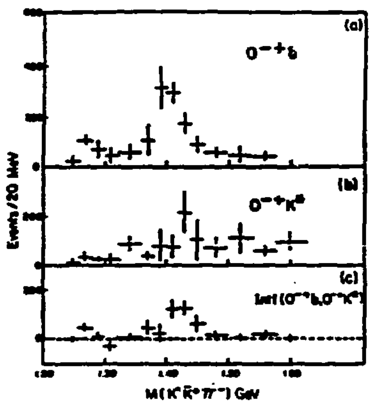

Fig. 3 Contributions to the 0^{-+} wave
a) δπ
b) K^*K
c) Interference term