FURTHER ANALYSIS OF D^0 MESON IN THE REACTION $\pi^+p \to p\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$ AT 8 GeV/c

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The existence of the intermediate $\delta\pi$ state in the decay $D^0 \to \eta\pi\pi$ is discussed. It is shown that the reflection of the ω production cannot produce a spurious maximum in the $(\eta\pi)$ mass distribution at the position of the δ.

In a previous publication [1] we reported on the production of the D^0 meson and its decay into $\eta\pi^+\pi^-$ in the reaction $\pi^+p \to p\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$ at 8 GeV/c. We presented indication for the decay chain $D^0 \to \delta^\pm\pi^\mp \to \eta\pi^+\pi^-$.

It has been pointed out in the Review of Particle Properties [2] that the "δ" peak in the $\eta\pi$ mass distribution may be a kinematical effect: "...In final states containing many pions (*e. g.*, $2\pi^+2\pi^-\pi^0$, $(3\pi)^\pm\pi^0$), and with the ω copiously produced, the constraint of at least one η combination in the $\pi^\pm\pi^+\pi^-\pi^0$ mass "fakes" a bump in the mass region around 960 MeV, due to reflections from the "ω".

In this report we discuss the relevance of this remark to our previous conclusion on the existence of the $\delta\pi$ intermediate state in the D^0 decay.

To investigate possible reflections from the ω, which is produced in 30% of the events in the studied reaction [3] we estimate first the number of the ω combinations in the sample of the D^0 events defined as follows: $1.275 < M(\pi_1^+\pi_2^+\pi_1^-\pi_2^-\pi^0) < 1.375$ GeV and at least one η in (*i. e.* $0.5 < M(\pi_1^+\pi_1^-\pi^0) < 0.6$ GeV).

The distribution of the $(\pi_1^\pm\pi_2^\mp\pi^0)$ mass *versus* $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$ mass for the selected D^0 events is plotted in Fig. 1. For both projected distributions we calculated the predictions of the modified phase space [3] (which is in this case practically equivalent to the relativistic phase space within the $(\pi_1^+\pi_2^+\pi_1^-\pi_2^-\pi^0)$ system), by generating Monte-Carlo events and applying the same cuts as those imposed on the data. The experimental distribution of the $(\pi_1^\pm\pi_2^\mp\pi^0)$ mass (projection *a*) agrees with the calculated curve normalized to the area of the histogram, and the estimated number of possible ω combinations is (4.5 ± 3.5).

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Later, from the modified phase space we calculated the contribution to the $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$ mass due to the assumed ω signal in the $(\pi_1^\pm\pi_2^\mp\pi^0)$ combinations, described by the Breit-Wigner formula. The result is shown as the shaded area in the projection *b*. The $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$

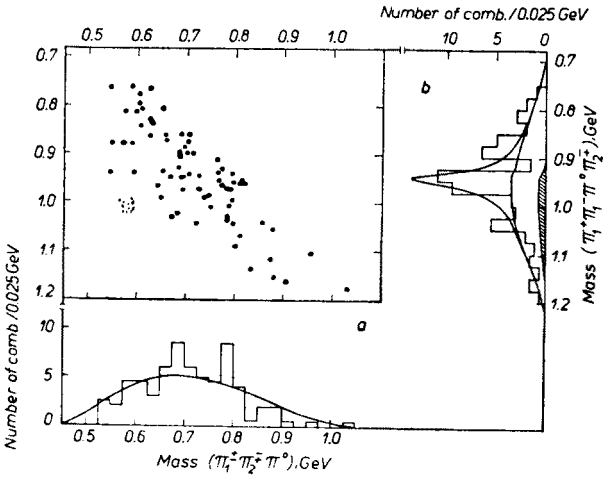

Fig. 1. Distribution of the $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$ mass *versus* $(\pi_1^\pm\pi_2^\mp\pi^0)$ mass for the D^0 events, *i.e.*, having the $(\pi_1^+\pi_2^+\pi_1^-\pi_2^-\pi^0)$ mass between 1.275 and 1.375 GeV and the $(\pi_1^+\pi_1^-\pi^0)$ mass in the η band. One D^0 combination contributes two points, corresponding to pion charges indicated by upper or lower set of signs. The combinations in the η band of the projection *a* originate from the $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$ combinations containing two "η" triplets. For explanation of the curves see text

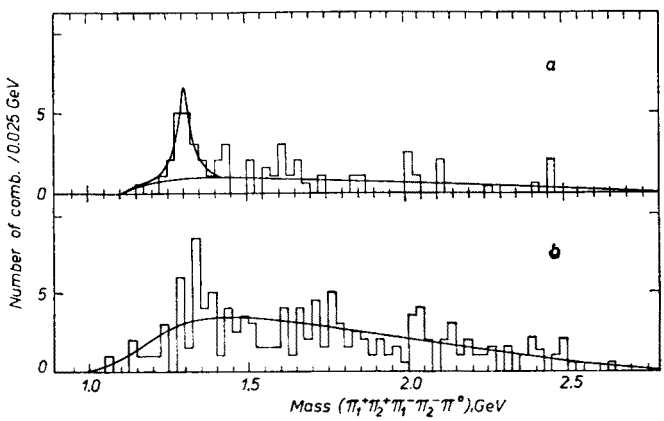

Fig. 2. Effective mass distribution of the $(\pi_1^+\pi_2^+\pi_1^-\pi_2^-\pi^0)$ system with the $(\pi_1^+\pi_1^-\pi^0)$ mass in the η band and *a*) the $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$ mass in the δ band (0.925–0.975 GeV), *b*) the $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$ mass in adjacent bands (0.8–0.925 GeV and 0.975–1.1 GeV). For explanation of the curves see text

mass distribution was fitted with the Breit-Wigner formula for the δ meson and the calculated background including the ω reflection. The probability of the fit was 65%. The obtained mass (947±7) MeV, width[1] (31±28) MeV and the number of events 21±7 agree well with the values reported previously (when the ω reflection was neglected).

[1] uncorrected for experimental resolution.

We conclude that in our experiment the reflection of the ω production cannot produce a spurious maximum at the δ mass. However, the δ peak is only a three-standard deviation effect and might be a statistical fluctuation.

Nevertheless, we shall further assume that the observed maximum in the $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$ mass is really due to the δ meson. Fig. 2a shows the effective mass distribution of the $(\pi_1^+\pi_2^+\pi_1^-\pi_2^-\pi^0)$ combinations having the $(\pi_1^+\pi_1^-\pi^0)$ mass in the η band and the $(\pi_1^+\pi_1^-\pi^0\pi_2^\mp)$ mass in the δ band (between 0.925 and 0.975 GeV). For comparison, in Fig. 2*b* instead of the δ the adjacent regions were taken (0.8–0.925 GeV and 0.975–1.1 GeV). The latter histogram is fairly well described by the modified phase space curve (with the probability of 60%), whereas the δ selection in Fig. 2a leads to the clean D^0 signal above a low background. The fitted mass of the D^0 is (1303 ± 8) MeV, width[2] (44 ± 24) MeV, the number of combinations 15.1 ± 4.6 and the probability of the fit 75%. The central value of the D^0 mass obtained by fitting the $\eta\pi^+\pi^-$ mass without selecting on δ is (1329 ± 10) MeV [1]. However, if the D^0 does decay in two steps $D^0 \to \delta^\pm\pi^\mp \to \eta\pi^+\pi^-$ then the value $M = (1303\pm8)$ MeV should be considered as a better estimate of its mass. It should be noted that the latter is closer to the values reported in other experiments [2].

REFERENCES

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[2] uncorrected for experimental resolution.