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INVESTIGATION OF THE M ($\pi^\circ \pi^\circ$) EFFECTIVE MASS SPECTRUM

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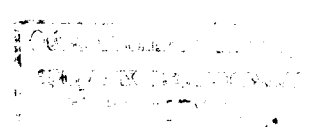

The well-known asymmetry in ρ^0 -decay has led some authors to suggest the existence of a spinless, isoscalar meson, ϵ^0 or S^0, with mass near the ρ^0 -meson[1]. Many investigators have tried to find ϵ^0 in the $\pi^0-\pi^0$ system[2-4], where the ρ^0 would not be seen. The application of the $\pi-\pi$ phase-shift analysis is very useful for explanation of this problem[5-6], however further experiments are needful, especially those concerning $\pi^0-\pi^0$ systems.

In this paper the search for particles decaying into $2\pi^0$ is performed by means of the effective mass method in the region of mass values less than 1300 MeV.

1. Method

The scanning of 500 000 photographs of the JINR xenon bubble chamber irradiated in 2.34 GeV/c π^+ beam was done twice for the interactions of $\pi^+ + Xe$ with one secondary observable charged particle stopping within the chamber, and accompanied by four γ -quanta. In each event the angle of γ -emission with the accuracy of $(0.5-2)^\circ$ and the energy of γ -quanta with the accuracy of

$\frac{\Delta E_\gamma}{E_\gamma} \leq 35\%$ were estimated. The effective mass $M_{2\gamma}$ and $M_{4\gamma}$ were determined combining two or four γ -quanta correspondingly. Further only those events were studied in detail in which two independent $\gamma-\gamma$ combinations, from six possible, gave the value for $M_{2\gamma}$ lying within the interval (90-180) MeV. Such interval was accepted as permissible for the π^0 -meson mass. The selected events can be interpreted as the interactions of the type

$$\pi^+ + n \to X + p \qquad X \to 2\pi^0 \qquad (1)$$

of π^+ with quasi-free neutrons in the xenon nuclei[7-8]. The precision of the effective mass $M^{4\gamma}_{4\gamma}(\pi^0\pi^0)$ estimation is about 10%.

2. Experimental Data

Out of 306 events with four γ -quanta satisfying scanning criteria the 154 events of the type (1) with $2\pi^0$ were selected. The recording probability of γ -quanta in the selected events is equal, in average, 84%.

The effective mass distribution $M^{4\gamma}_{4\gamma}(\pi^0\pi^0)$ is shown in Fig.1. The curve 1 presents the mass distribution of random combinations normalized to $M^{4\gamma}_{4\gamma}(\pi^0\pi^0) \leq 550$ MeV. The curve 1 was evaluated by the Monte-Carlo program using experimental angular and energetic spectra of γ -quanta from selected sample of events of the type (1). The curve 2 normalized to the all number of $\pi^0-\pi^0$ -events presents the phase space for the reaction $\pi^+ + n \to \pi^0 + \pi^0 + p$ by 2.34 GeV/c π^+ -meson momentum.

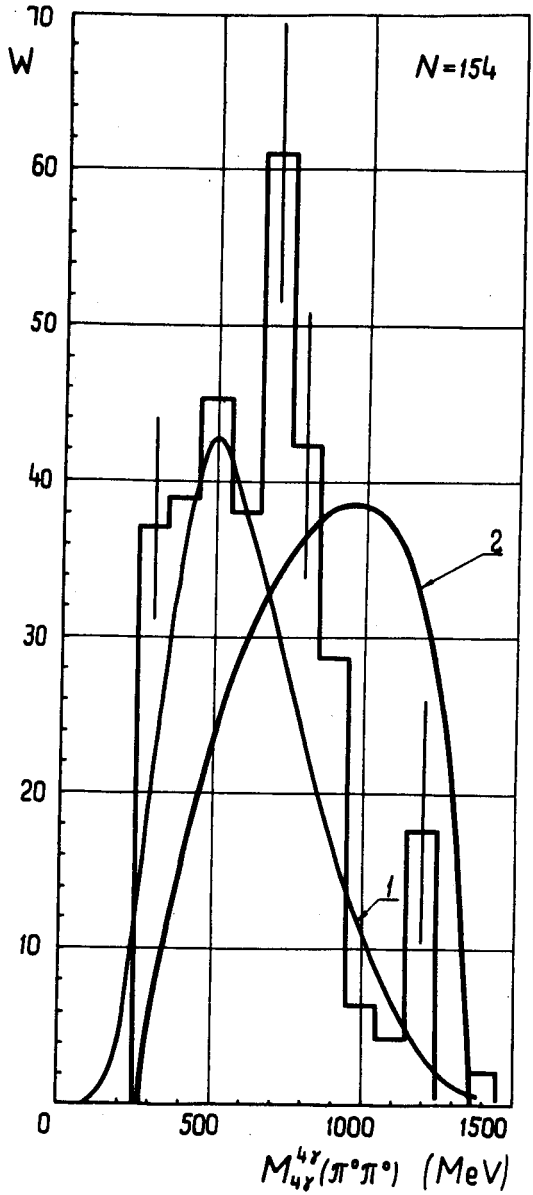

Fig.1. Distribution of the effective mass $M^{4\gamma}_{4\gamma}(\pi^0\pi^0)$.
The curve 1 represents the distribution of random $\pi^0-\pi^0$ combinations normalized to the mass value $M^{4\gamma}_{4\gamma} \leq 550$ MeV.
The curve 2 shows the phase space for reactions $\pi^+ + n \to \pi^0 + \pi^0 + p$ for 2.34 GeV/c π^+ momentum,.

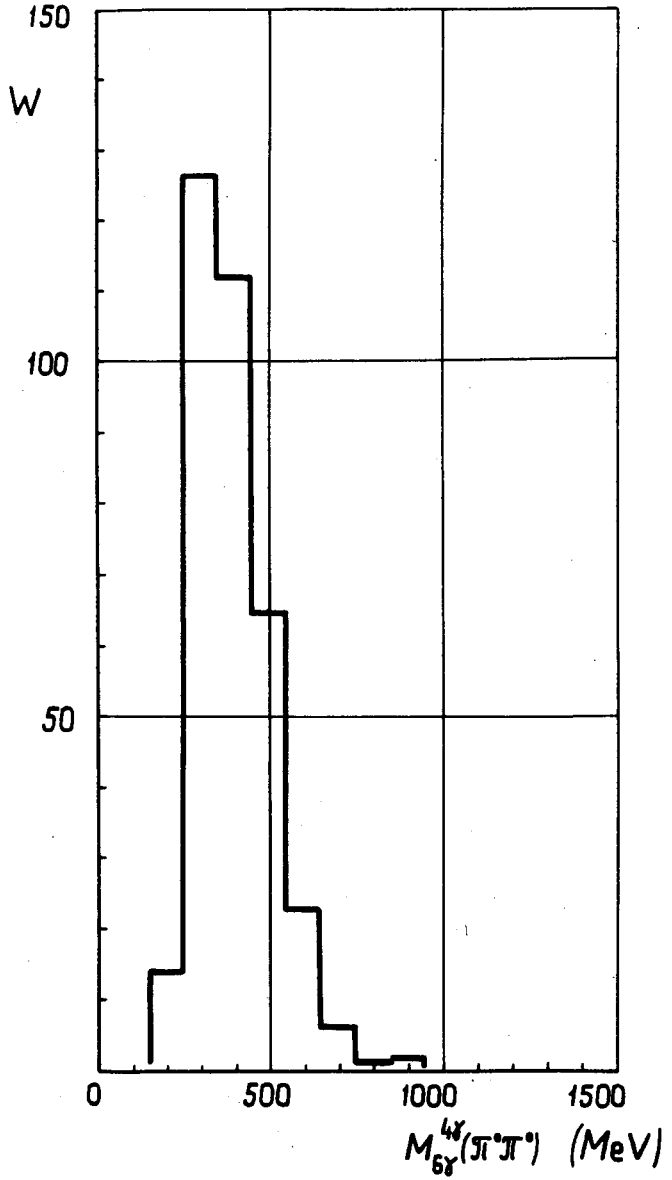

Fig.2. Distribution of the effective mass $M_{6\gamma}^{4\gamma}(\pi^0\pi^0)$ for six γ-events.

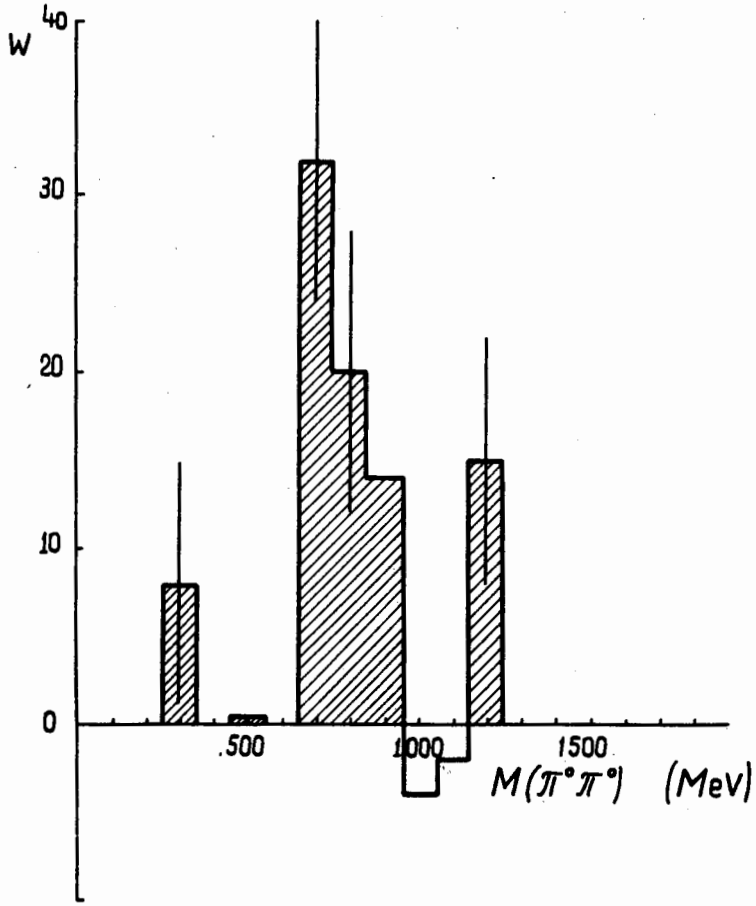

Fig.3. Distribution of the effective mass $M^{4\gamma}_{4\gamma}(\pi^0\pi^0)$ without background.

Fig.2 presents the distribution of the effective mass $M^{4\gamma}_{6\gamma}(\pi^0\pi^0)$ for six γ-events. The localization of the maximum in this distribution is far from the maximum in that distribution presented in Fig.1. The contamination of the $M^{4\gamma}_{6\gamma}(\pi^0\pi^0)$ events in the $M^{4\gamma}_{4\gamma}(\pi^0\pi^0)$ effective mass distribution is small, making up about 4%. In Fig. 3 the mass spectrum of $M^{4\gamma}_{4\gamma}(\pi^0\pi^0)$ is shown without the background.

3. Results and Discussion

The effective mass spectrum of the $M^{4\gamma}_{4\gamma}(\pi^0\pi^0)$ shows evidence of the peak in the region of the mass values (650 -850) MeV. The average value which can be attributed to this peak equals $\bar{M}(\pi^0\pi^0) = 730 \pm 15$ MeV.

Using information about the intensity of production of $\eta \to 2\gamma$ recorded in our experiment in one-prong two γ-events we estimate the relative intensity of production of the $\pi^0-\pi^0$ system corresponding to the peak:

$$\frac{N(\pi^0-\pi^0)}{N(\eta \to 2\gamma)} = 0.47 \pm 0.16 \ . \quad (2)$$

Assuming the relation (2) will be the same for the elementary $\pi^+ + n$ interactions at 2.34 GeV/c, and using the value of intensity of $\eta \to 2\gamma$ channel, we estimate the relation between cross sections:

$$\sigma[\pi^+ + n \to (\pi^0\pi^0) + p] \approx 0.1\, \sigma[\pi^+ + n \to \eta + p]. \quad (3)$$

It was determined that the possible decay of the isobar $N^{*+}(1238)$ has not any influence on the effective mass distribution near the observed peak.

References

1. V.Hagopian, W.Selove. Phys. Rev. Lett., 10, 533 (1963); SOBB Coolaboration, Nuovo Cim., 29, 515 (1963); M.M.Islam and R.Pinon. Phys. Rev. Lett., 12, 310 (1964); S.H.Petil. Phys. Rev. Lett., 13 261 (1964); I.Derado, V.P.Kenney, J.A.Poirier and W.D.Shephard. Phys. Rev. Lett., 14, 872 (1965).
2. M.Feldman, W.Frati, J.Halpern, A.Kanofsky, M.Nussbaum, R.Richert R.Richert, P.Yamin, A.Choudry, S.Devons, J.Grunhaus. Phys. Rev. Lett., 14, 869 (1965); Z.S.Strugalski, I.V.Chuvilo, I.A.Iyanovskaya, L.S.Okhrimenko, B.Niczyporuk, T.Kanarek, Z.Jablonski, B.Slowinsli. Preprint E1-3100, Dubna , USSR, 1968; I.F.Corbett, C.J.S. Damerell, N.Middlemass, D.Newton, A.B.Clegg, W.S.C.Williams and A.S.Carroll. Phys. Rev., 156, 1451 (1967).
3. H.O.Cohn, W.M.Bugg, G.T.Condo, R.D.McCulloch, G.Luetjens and N.Gelfand. Phys. Rev. Lett., 15, 906 (1965).
4. A.Forino, Gessaroli L. Lendrinara, G.Quareni, A.Quareni-Vingudelli, A.Romano, J.Laberigue-Frolov, J.Quinqart, M.Sene, W.Finkinger, O. Gussu and A.Rogozinski. Physics Lett., 19, 65 (1965).
5. E.Malamud, P.Schlein. Phys. Rev. Lett., 19, 1056 (1967).
6. S.Maratec k, V.Hagopian, W.Selove, L.Jacobs, F.Oppenheimer, W.Schultz, L.J.Gutay, D.H.Miller, J.Prentice, E.West, W.D.Walker. Phys. Rev. Lett. (in press).
7. Z.S.Strugalski, T.Siemiarczuk. Phys. Lett., 13, 347 (1964).
8. M.Daszkiewicz, B.Slowinski, Z.S.Strugalski. Journal of Nuclear Physics, 5, 341 (1967).

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