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EVIDENCE FOR A NEW $0^{-}S$ RESONANCE IN THE DIFFRACTIVELY PRODUCED 3π-SYSTEM

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In the 5-th joint CERN-JINR experiment (Bologna-Dubna-Milan collaboration) at the IHEP accelerator (40 Gev π^--beam) the reaction

$$\pi^- + A \to \pi^+ + \pi^- + \pi^- + A \quad (1)$$

of the pion diffractive dissociation on nuclei, was investigated by the magnetic spark spectrometer (MSS-JINR) set-up. About 120 thousand events of the type (1) have been detected on 9 nuclear targets (Be, C, Al, Si, Ti, Cu, Ag, Ta, Pb) with the transferred momentum t' less than that for the first diffractive minimum for each target. The experimental set-up and obtained results were presented elsewhere/1,2,3/.

In these papers we have reported on observation of two resonances in the three-pion system with quantum numbers of π-meson which have been interpreted as pion radial excitations. The masses M and widths Γ of the resonances are:

$$M=1240\pm30 \text{ MeV} \qquad M=1770\pm30 \text{ MeV}$$

$$\Gamma = 360\pm35 \text{ MeV} \qquad \Gamma = 310\pm50 \text{ MeV}.$$

Now these both resonances have been independently confirmed/4,5/. An attempt was undertaken to make a joint description of excitation levels of ρ and π mesons in paper/6/. But the satisfying results have not been obtained and the authors suggested that there should be one more pion radial excitation with a mass in the range of 700-800 MeV. [1] As is shown in work/7/, the estimate of the situation in this mass range may be done with the earlier obtained data.

We have performed the partial-wave analysis of the experimental data of the old MSS set-up in the three-pion effective mass region lower than 900 MeV, which have not been studied, (Fig. 2) in papers/1,2,3/. We have used the program of Illinois University/8/, as before. The difficulties of the analysis in this range are: a) the geometrical efficiency of the set-up decreases/9/, (Fig. 3); b) only about 5000 events are left for the analysis.

It has been found earlier/2/ that 5 partial waves $0^-S, 0^-P, 1^+S, 1^+P$ and 2^-D are enough to describe the process (1). The possible contribution of waves 0^+, 1^- and 2^+, was suppressed as soon as the spectrometer trigger system selected the events

[1] This hypothesis does not contradict the results of works /1,2,3/ as soon as the experimental data analysis from MSS set-up was performed in the mass range higher than 900 MeV, Fig. 1.

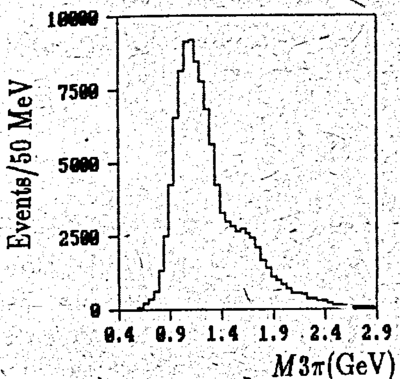

Fig.1. Distribution of 3-pion invariant masses with t' less than that for the first diffractive minimum

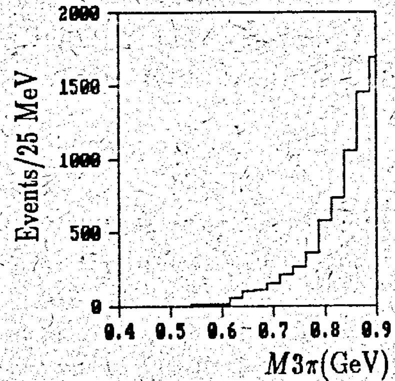

Fig.2. The same as in Fig.1., mass range less than 900 MeV

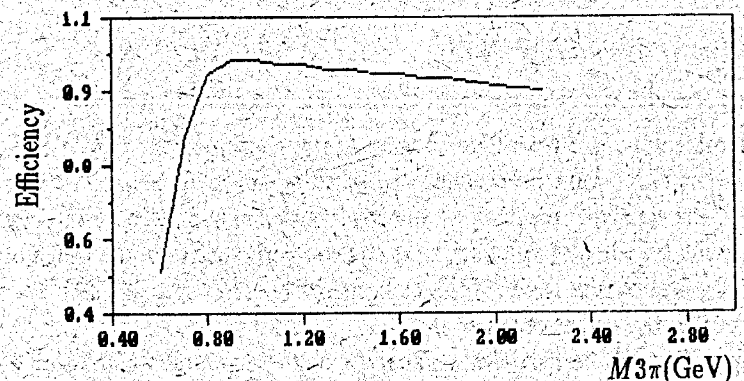

Fig.3. Geometrical efficiency of MSS-JINR set-up as function of the 3π effective mass

without excitation of the target nucleus. The description of the resonance decay into three pions, has been performed with the cascade model - through pion plus dipion. Dipions with state $J^p = 1^-$ and 2^+ are very well described with $\rho(770)$ and $f_2(1270)$ resonances, respectively, and for dipion in state 0^+ we have used phase shifts of $\pi\pi$

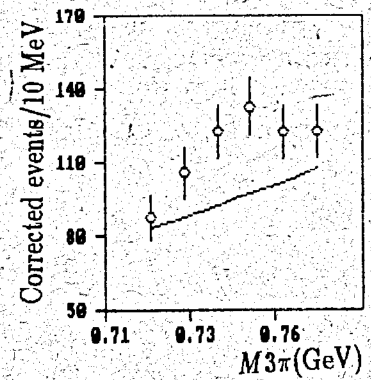

Fig.4. 3π mass dependence of intensity of the wave 0^-S

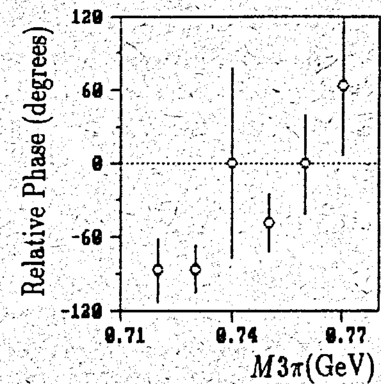

Fig.5. 3π mass dependence of $(0^-S - 0^-P)$ relative phase

elastic scattering[10]. The data from all the nine targets were summarized for the analysis. The partial wave analysis has been performed in the range of three-pion effective masses from 600 up to 900 MeV. The results for the wave 0^-S are presented in Fig. 4. The variation in the relative phase $(0^-S - 0^-P)$ (Fig. 5) is observed from -90^0 to $+60^0$ for $3\pi-$masses from 720 to 770 MeV (the arguments to use wave 0^-P as the reference wave, are the same as in paper[3]). Such behavior of the relative phase indicates the existence of the resonance state in 0^-S wave. To determine the parameters of this resonance, the fit of 0^-S wave intensity has been performed with Brait-Wigner function and exponential background assuming that the phase of 0^-P wave in the region of 720–770 MeV, is constant. Non-resonance background is shown in Fig. 4 with full line (the parameters of this background exponent determined by using intensity of 0^-S wave beyond resonance region 720–770 MeV). The following resonance parameters have been obtained:

$$M=749\pm30 \text{ MeV} \qquad \Gamma=32\pm17 \text{ MeV},$$

where the errors are only statistical. The performed analysis allows one to conclude that there is some resonance state in the three-pion system with quantum numbers of π-meson in the mass range predicted in paper[6] for the first radial excitation.

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