Study of the reaction: $\pi^- p \rightarrow \eta\pi^+\pi^-\pi^- p$ in E852 experiment.

D.Ryabchikov, E852 collaboration

Abstract.

The results of the Partial Wave Analysis of the reaction $\pi^- p \rightarrow \eta\pi^+\pi^-\pi^- p$ are presented.

The analysis included study of $f_1(1285)\pi^-, a_0(980)\rho(770), a_2(1320)\eta$ and also $\eta'(985)\pi^-$ channels. The dominant partial waves in $f_1(1285)\pi^-$ system are $J^{PC} = 1^{++}$, 1^{-+} exotic wave and 2^{-+}. The $\eta'(985)\pi^-$ system is dominated by exotic $J^{PC} = 1^{-+}$ wave, peaking near 1.6 GeV. The intensity of $2^{++}\eta'\pi^-$ wave shows clearly the $a_2(1320)$ signal, and also some bump near 1.75 GeV. Both $f_1(1285)\pi^-$ and $\eta'\pi^-$ systems show the small signal from $a_4(2030)$ meson in 4^{++} wave. The mass-dependent analysis is in progress.

INTRODUCTION

The reaction $\pi^- p \rightarrow \eta\pi^+\pi^-\pi^- p(1)$ goes through several intermediate channels: $f_1(1285)\pi^-, a_0(980)\rho(770), a_2(1320)\eta$ and $\eta'(985)\pi^-$.

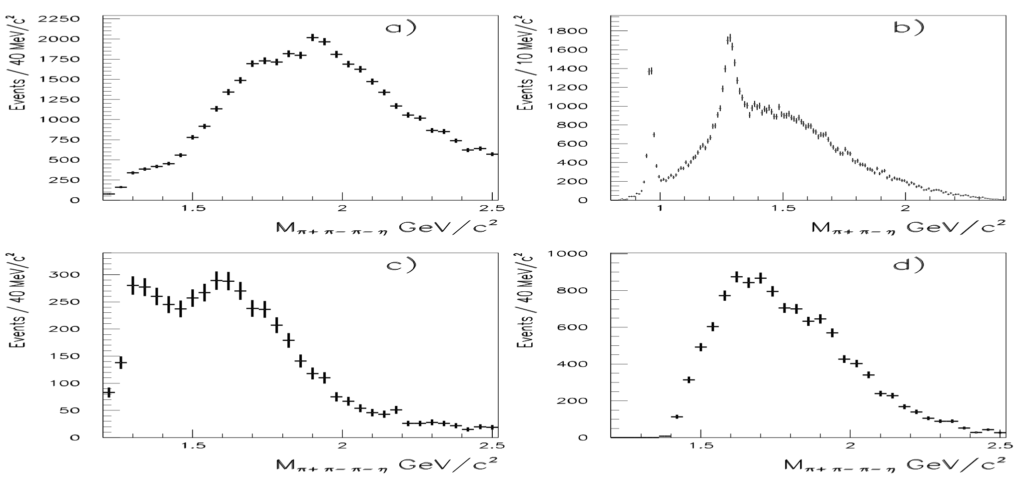

FIGURE 1. Some mass spectrums for $\eta 3\pi$ events.

Study of $f_1(1285)\pi^-$ final state is interesting because flux-tube model predicts decays of 1^{-+} exotics to $f_1\pi$ [1].

The radial exitations of $q\bar{q}$ mesons, such as $a_1(1700)$, $a_3(2080)$, $a_2(1700)$, $\pi_2(1800)$ can be detected in various channels, finally decaying to $\eta 3\pi$.

Some results for $J^{PC} = 1^{++}$ and 1^{-+} states in $f_1\pi$ system were reported by VES [4] and E818 [3].

The MultiParticle Spectrometer(MPS) facility in E852 experiment is capable of studying various exclusive reactions : $\pi^- p$ going to several charged and neutral particles and recoil proton(neutron).

The 42 000 events of the reaction (1) were selected, using 46 M triggers, which regarded 3 charged tracks, recoil proton and η- meson in LGD.

The data shows $f_1(1285)/\eta(1295)$ and $\eta'(985)$ signals (fig.1-b). The raw $\eta 3\pi$ (fig.1-a), and $f_1\pi^-$(fig.1-d) invariant mass distribution are structurless. The $a_2(1320)$ meson is seen in $\eta'\pi^-$ mass spectrum, followed by some bump in 1.6 GeV region(fig.1-c).

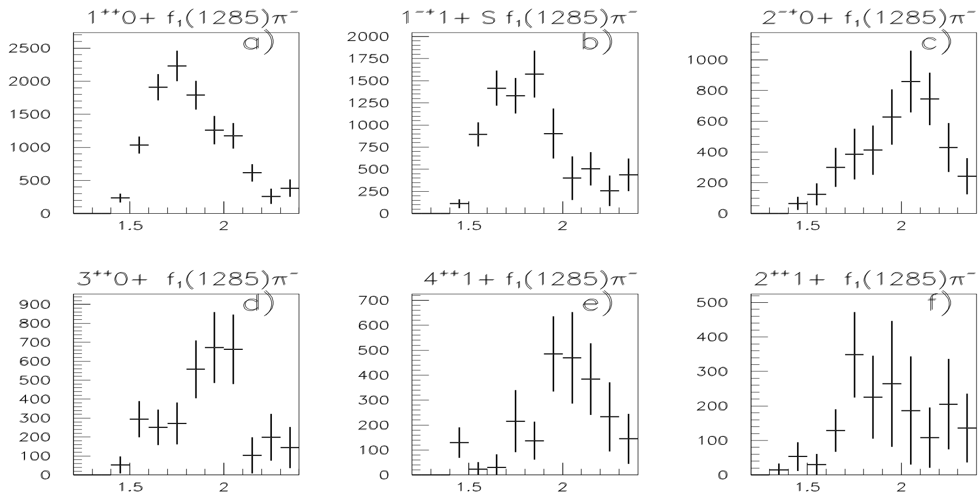

FIGURE 2. The waves intensities in $f_1\pi$ system. The notations are: $J^{PC}M\eta$.

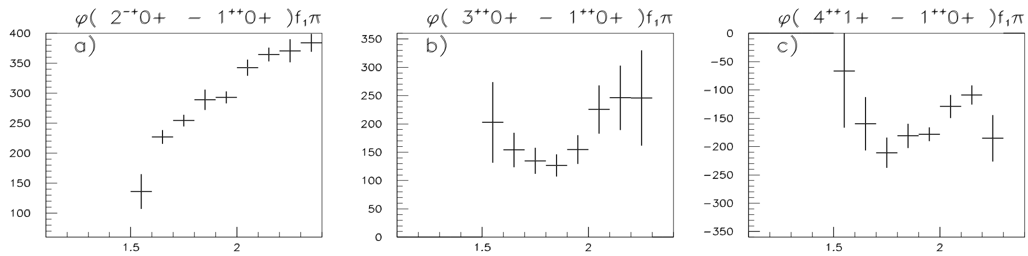

FIGURE 3. Some phases in $f_1\pi$ sector.

THE RESULTS OF ANALYSIS

Some features of 4-particle PWA, are listed below. The amplitudes were written using non-relativistic tensor formalism.

The spin density matrix in Gottfried-Jackson system is block diagonal with respect to naturalities of produced states. It is built using Chung-Trueman parametrisation [2]. The maximal rank=2 is used for $f_1\pi$ system.

The $f_1\pi, a_0\rho, a_2\eta, \eta'\pi$ systems are fitted simultaneously.

Fig.2 shows $f_1\pi$ waves intensities.

The most intensive wave is $J^{PC} = 1^{++}$ which can be interpreted as the signal from $a_1(1700)$ meson. The mass value for this object, coming from Breit-Wigner fits, varies from 1.67 to 1.75 GeV, depending upon the mass-dependent dinamical width parametrisation. The width of $a_1(1700)$ is near 400 MeV.

The $1^{-+}Sf_1\pi$ intensity is significant in 1.5 - 2.1 GeV interval. It has an enhancement near 1.6 GeV and some bump in 1.85 GeV region. This picture is stable in many PWA fits.

The $2^{-+}f_1\pi$ wave peaks near 2.0 GeV, and has strongly rising phase relative to 1^{++} wave. Such behavior can be described by two BW poles in 2^{-+} wave:$\pi_2(1670)$ followed by the state with mass near 2.0 GeV and width more than 300 MeV.

The $2^{++}, 3^{++}, 4^{++}f_1\pi$ waves are rather small, but the PWA shows clearly their interference with the dominant 1^{++} wave. The $3^{++}, 4^{++}$ states have rising phases relative to 1^{++} in 2.0 GeV region; this can reflect the decays of $a_3(2080)$ and $a_4(2030)$ mesons to $f_1\pi$.

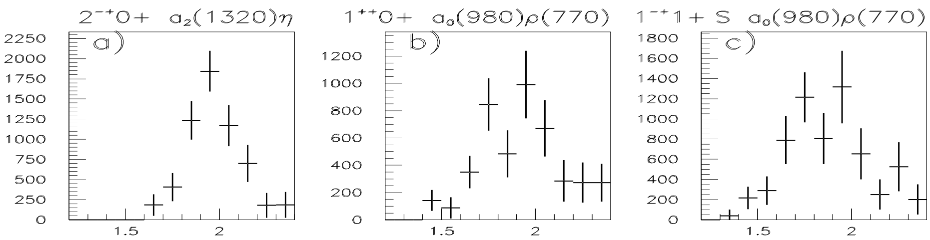

FIGURE 4. The waves intensities in $a_2\eta$ and $a_0\rho$ systems.

The $a_2(1320)\eta$ system is dominated by $2^{-+}S$ wave(fig.4-a). However it doesn't show a fast phase variation(not shown), consistent with rather narrow width of 2^{-+} intensity distribution .

The dominant waves in $a_0\rho$ system are 1^{++} and 1^{-+} (fig.4-b,c). The $1^{++}a_0\rho$ and $1^{++}f_1\pi$ have small relative phase variation in wide mass intervall, showing their similar nature.

The $\eta'\pi$ system is dominated by exotic 1^{-+} wave(fig.5-a). The 2^{++} wave(fig.5-b) shows the $a_2(1320)$ meson and some bump at 1.75 GeV. The $2^{++} - 1^{-+}$ phase (fig.5-d) shows some rise in 1.32 GeV region, and then exhibits small variations.

This picture can be explained, using two BW poles for the description of 2^{++} wave, and one - for 1^{-+} wave. For obtaining the numerical results, the detailed study of $a_2(1700)$ in various decay modes is needed.

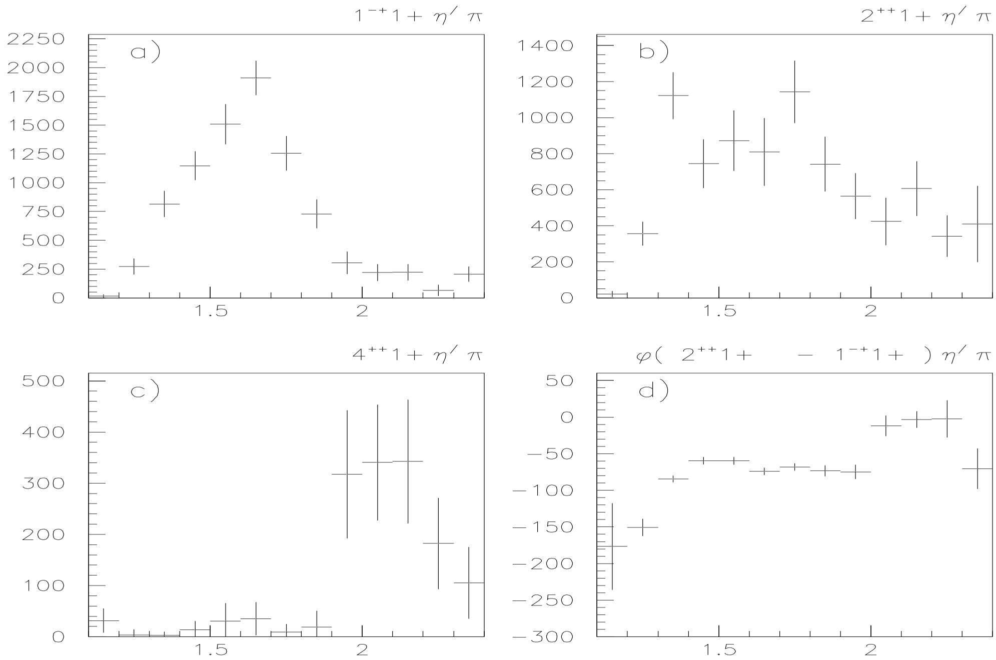

FIGURE 5. The PWA results for $\eta'\pi$ system.

The $4^{++}\eta'\pi$ shows a small signal of $a_4(2030)$ meson (fig.5-c).

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