A study of the $(\omega\pi^{\pm}\pi^{\mp})$ state, where $\omega \to \pi^+\pi^-\pi^0$ in the reaction $\pi^- p \to \pi^+\pi^+\pi^-\pi^-\pi^0 n$ at 18 GeV/c

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Abstract. This study is based on a subset of events of the type $\pi^+\pi^+\pi^-\pi^-\gamma\gamma$, from the $\pi^- p$ interaction in the 1995 run of E852, *A Search for Mesons with Unusual Quantum Numbers* at the MPS facility of BNL. The data set is reduced such that it contains events of the type $\omega\pi^-\pi^+$ to be used in the Partial Wave Analysis (PWA) of the system. In the $\omega\pi^{\pm}$ and the 4π mass spectra, we observe $b_1(1235)$ and $\rho_3(1690)$ signals. In the $\pi^-\pi^+$ off of the ω we see a large contribution due to $\rho(770)$ followed by a smaller contribution due to $f_2(1270)$. The $b_1^{\mp}$ production seems to be enhanced for the $\omega\pi^-\pi^+$ mass near 2 GeV, with more b_1^- produced than b_1^+. A spin parity analysis of the $\omega\pi^-\pi^+$ system to look for radial excitations and states with exotic quantum numbers is under way.

THEORETICAL MOTIVATION

As is well known, QCD allows for the existence of such gluonic states as hybrids $(q\bar{q}g)$ in the spectrum of mesons. These are states outside those predicted by the constituent quark model. Models such as the Flux Tube model [2] predict hybrid mesons in the mass range $1.8 - 2.0$ GeV/c which decay to $S + P$ combination of mesons such as $b_1\pi$ [3]. Recent calculations by B.C.P.S. [4] suggest strong coupling of the radially excited $a_1(1800)$ to $(\omega\rho)$. Here we show the quality of the data by pointing out the expected resonances in the mass spectra at different stages of topological and kinematical selections/cuts on the initial set of $\pi^+\pi^+\pi^-\pi^-\gamma\gamma$ data. The statistics of the final $(\omega\pi^{\mp}\pi^{\pm})$ data set is sufficient to do a full Partial Wave Analysis (PWA) analysis.

DATA SELECTION

Out of the 96M raw triggers requiring a neutral recoil, any number of photons incident on the Lead Glass calorimeter and four hits in each of the two downstream proportional chambers *, 2.6M events of the type $\pi^+\pi^-\pi^+\pi^-\gamma\gamma$ remain. A clear π^0 and a hint of η signals are observed in the $\gamma\gamma$ mass spectrum shown in Fig. 1a.

* For details of the experimental setup refer to the paper by A. Ostrividov in these proceedings [1].

Next, kinematical package, SQUAW [5], was used to constrain the mass of the recoil to that of the neutron and the $\gamma\gamma$ mass to that of the π^0. 808K events of the topology $\pi^+\pi^-\pi^+\pi^-\pi^0$ remain after a 5% confidence level. Fig. 1b shows the $\pi^+\pi^-\pi^0$ mass spectrum with four entries per event. We identify 245K $\omega\pi^-\pi^+$ events by requiring that any one of the four $\pi^+\pi^-\pi^0$ mass combinations to be within 50 MeV of the PDG [6] value listed for the ω mass. No clear structure is observed in the $\omega\pi^-\pi^+$ spectrum as evident in Fig. 1c. We see more b_1^- and ρ_3 than b_1^+ and ρ_+ in the $\omega\pi$ spectrum 2. The $\omega\rho$ spectrum is shown in 1. There is an indication of a structure around 1.7 GeV or around 1.9 GeV, without a PWA, it is not possible to draw any conclusions. In Fig. 2, we have shown the possible isobars. $b_1(1235)$, $\rho_3(1690)$ are the isobar candidates for $\omega\pi^\pm$ and $rho(770)$, $f_0(980)$, $f_2(1270)$, $f_0(1370)$, $(\pi\pi)_S$ are isobar candidates for $(\pi^+\pi^-)$. From the figure, it is clear that b_1 and ρ are the strongest isobars and we expect the dominant waves to come from the $b_1\pi$ and $\omega\rho$ systems. One other feature observed in the data is that the b_1 signal is strongest in the $\omega\pi^-\pi^+$ between 1.8 and 2.2 GeV. This can be seen from Fig. 3 where $\omega\pi^-$ and $\omega\pi^+$ mass spectra are plotted for 400 MeV window cuts of the $\omega\pi^-\pi^+$ mass between 1.4 and 3.0 GeV.

FUTURE PLANS

The $\omega\pi^-\pi^+$ system may be populated with overlapping and broad resonanc. We will do a spin analys of the $\omega\pi^-\pi^+$ systems as a whole, including the possible $\omega\pi$ and $\pi\pi$ isobars. No cut will be done either on the mass of the $\pi\pi$ off of the ω or on the mass of mass of $\omega\pi$. We believe there is sufficient statistics and good angular acceptance, allowing us to do a full PWA on this set of data. The first results of the PWA fits should show the significance of the isobars mentioned above and the dominant waves in each of the isobar-bachelor combinations. This would aid in reducing the number of input parameters to be used in the subsequent fits.

REFERENCES

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FIGURES

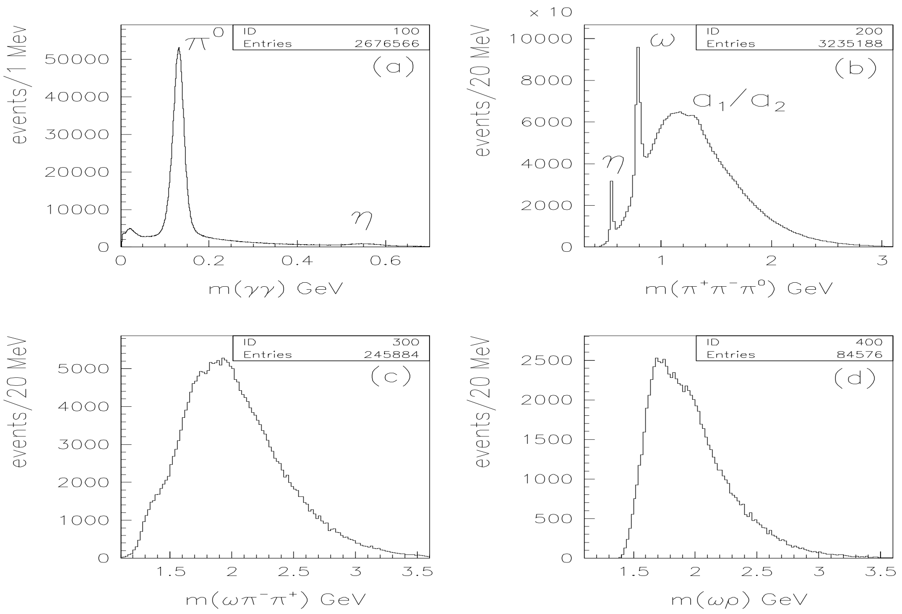

FIGURE 1. Effective mass spectra from the E852 $\pi^+\pi^-\pi^+\pi^-\gamma\gamma$ data sample. (a) $(\gamma\gamma)$ effective mass (b) $\pi^+\pi^-\pi^0$ effective mass $(4 entries/event)$ (c) $\omega\pi^-\pi^+$ effective mass

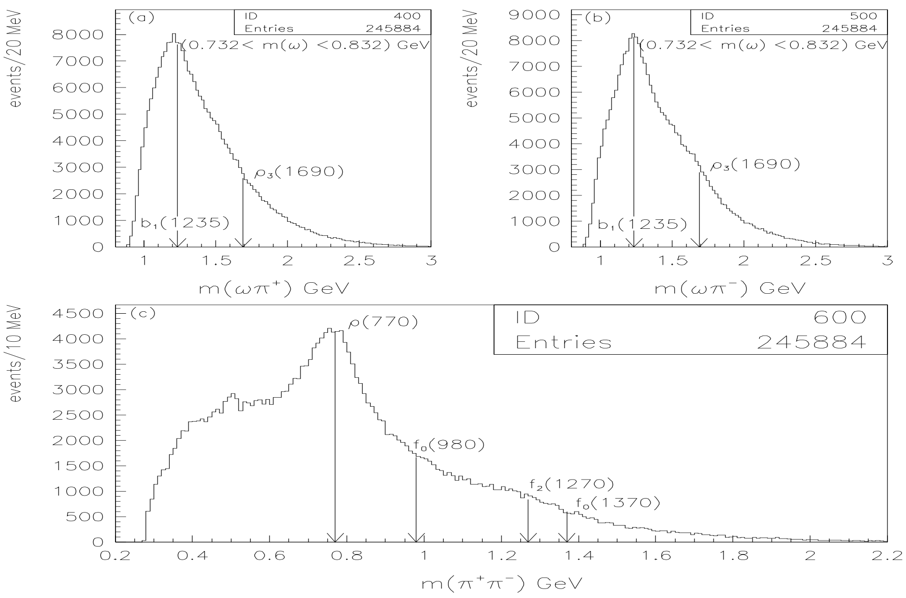

FIGURE 2. (a) and (b) Isobars in $(\omega\pi)$ (c) Isobars in $(\pi\pi)$

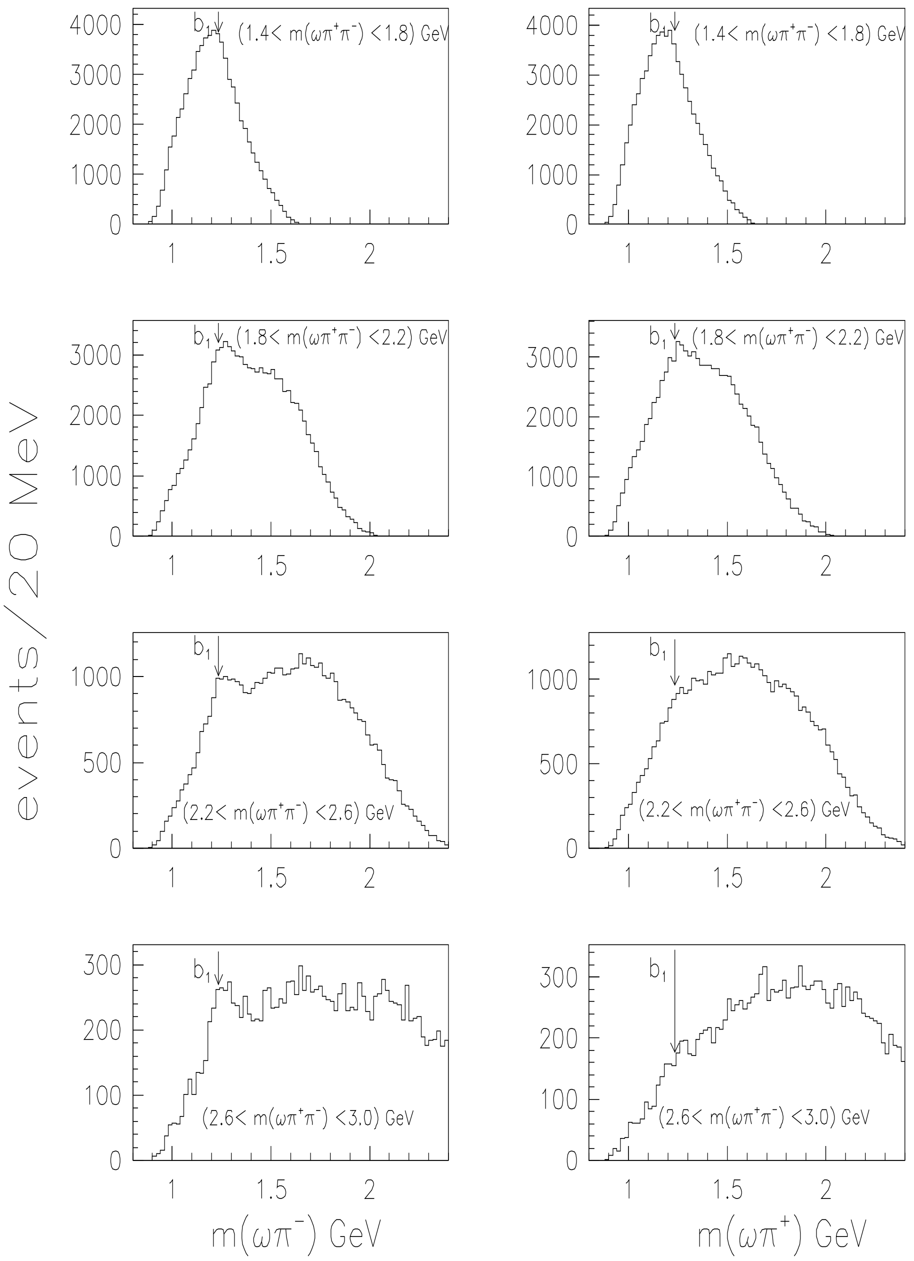

FIGURE 3. The $b_1^{\pm}(1235)$ production dependence on the $(\omega\pi^-\pi^+)$ mass. (a) $\omega\pi^-$ mass spectrum GeV/c (b) $\omega\pi^+$ mass spectrum GeV/c