A Study of the $\omega\eta$ and $\omega\pi^o$ Systems Produced in the Reaction $\pi^- p \to \pi^+\pi^- 4\gamma n$ at 18 GeV/c

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Abstract. Results are presented on a study of resonant structure in the $\omega\eta$ and $\omega\pi^0$ final states produced in $\pi^- p$ interactions at 18 GeV/c where $\omega \to \pi^+\pi^-\pi^0$, $\pi^0 \to 2\gamma$, and $\eta \to 2\gamma$. Final states, such as $\omega\eta$ and $\omega\pi^0$, which contain a vector meson, are allowed in the extended flux-tube model for the decay of hybrid mesons. In the $\omega\pi^0$ final state, the data exhibit the well-known $b_1(1235)$ and the $\rho_3(1690)$ resonances. A one-pion exchange mechanism is clearly seen for the $\rho_3(1690)$. A detailed partial wave analysis of both $\omega\eta$ and $\omega\pi^0$ is currently in progress.

INTRODUCTION

Studies of meson spectra via strong decays of hadrons provide insight regarding QCD at the confinement scale. These studies have led to phenomenological models for QCD such as the constituent quark model. However, QCD demands a much richer spectrum of meson states. The study of these extra states, known as hybrids ($q\bar{q}g$) and glueballs(gg), is the focus of Brookhaven National Laboratory Experiment E852, *A Search for Mesons with Unusual Quantum Numbers.* Presented here are recent results from E852 for $\pi^- p \to X^o n$ where $X^o \to \omega\eta$ and $X^o \to \omega\pi^o$; $\omega \to \pi^+\pi^-\pi^o$, $\pi^o \to \gamma\gamma$, and $\eta \to \gamma\gamma$. A description of the E852 apparatus is given in these proceedings by A. Ostrovidov [1].

A total of 108 million triggers with 2 charged tracks were taken during the 1995 data run. Six million $n\pi^+\pi^-4\gamma$ events remained after geometrical analysis and event selection. After the initial cuts on the data, the remaining events were kinematically fitted constraining the neutron, π^o, and η masses. Events were selected where the 4γ formed either $\pi^o\eta$ or $\pi^o\pi^o$ meson combinations. A total of 2.1 million $\pi^+\pi^-2\pi^o$ events remained for studying the $\omega\pi^o$ system, and 113 thousand $\pi^+\pi^-\pi^o\eta$ events remained for studying the $\omega\eta$ system.

$\omega\pi^O$ ANALYSIS

The $\omega\pi^o$ system is being examined for possible hybrid meson states. An attractive feature of this channel is that both the π^o and the ω are narrow states.

Prominent ω and η signals appear in the accepted 3π effective mass spectrum shown in Figure 1a. The 4π effective mass spectrum before an omega selection is shown in Figure 1b. After an omega selection, resonant-like structures are clearly visible at the $b_1(1235)$ and $\rho_3(1690)$ regions in the accepted $\omega\pi^o$ effective mass spectrum in Figure 1c. Figure 2 shows enhanced $\rho_3(1690)$ production at low $|t|$.

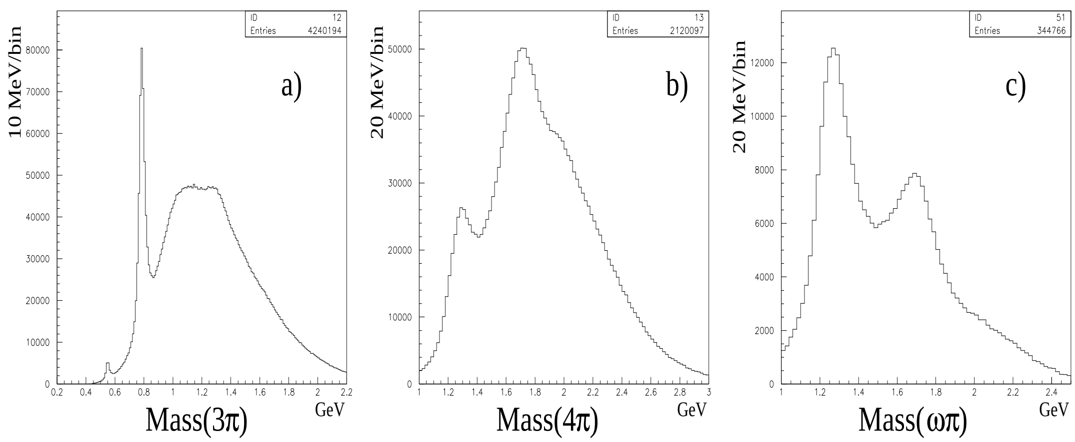

FIGURE 1. The accepted effective mass spectra for the $\pi^-\pi^+\pi^o\pi^o$ final meson state. a) $\pi^+\pi^-\pi^o$ effective mass (2 entries/event) b) $\pi^+\pi^-2\pi^o$ effective mass c) $\omega\pi^o$ effective mass

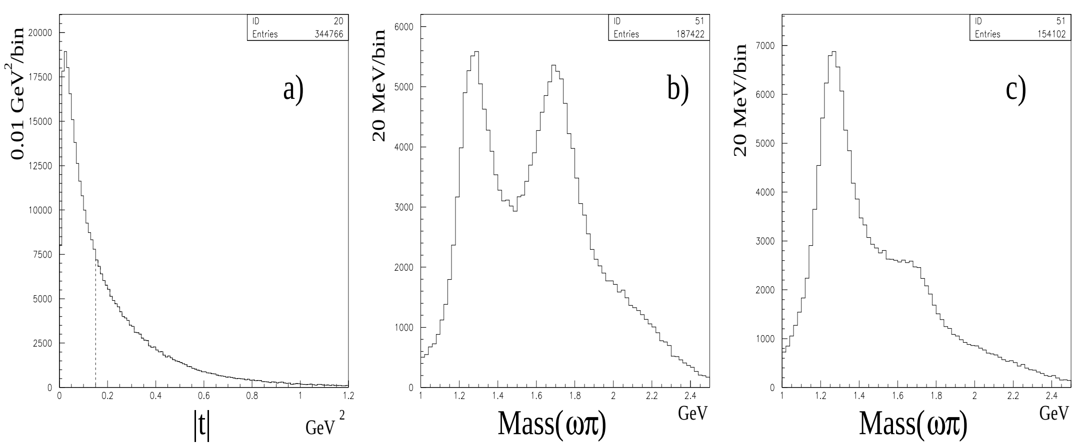

FIGURE 2. The $\omega\pi^o$ spectrum dependence on the four-momentum transfer $|t|$. a) four-momentum transfer $|t|$ $(GeV/c)^2$ b) $\omega\pi^o$ spectrum for $0 < |t| < 0.15$ c) $\omega\pi^o$ spectrum for $0.15 < |t| < 1.2$

This low $|t|$ production suggests one-pion exchange production for $\rho_3(1690)$.

Figures 3 and 4 display the dominant features of the $\omega\pi^o$ partial wave analysis. As expected, there are clear signals for b_1 in the 1^{+-} S and D waves and ρ_3 in the 3^{--} wave. The 3^{--} waves for different M^ϵ; 1^+, 0^-, and 1^- (The amplitudes are parameterized in the reflectivity basis [2]) are shown in Figure 4a. The $\rho_3(1690)$ is produced dominantly in the 0^- state as expected for one-pion exchange. It should be noted that the exotic waves, $J^{PC}0^{--}$ and 2^{+-} (4 waves out of 28 total waves allowed in the PWA fit), do not show any indication of resonant structure (not shown).

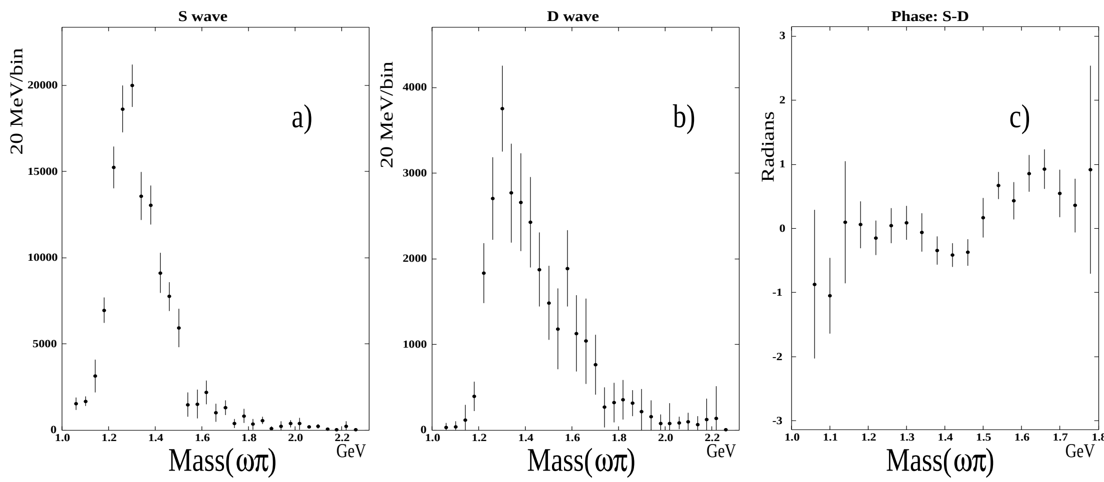

FIGURE 3. a) $J^{PC}M^\epsilon 1^{+-}0^+$ S wave intensity b) $J^{PC}M^\epsilon 1^{+-}0^+$ D wave intensity c) phase difference of D wave to S wave

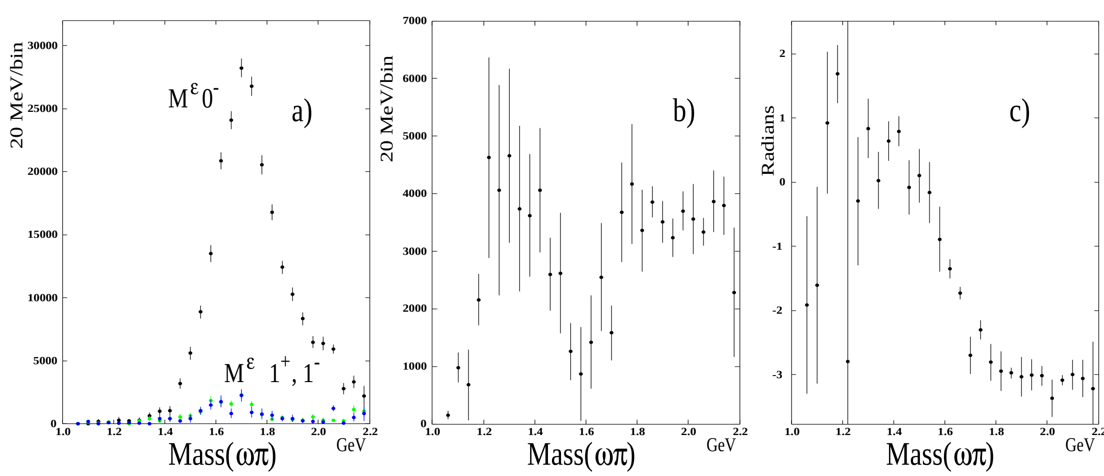

FIGURE 4. Dominant partial wave results. a) $J^{PC}3^{--}M^\epsilon(0^-, 1^-$, and $1^+)$ F wave intensities b) $J^{PC}M^\epsilon 1^{--}0^-$ P wave intensity c) phase difference of $(1^{--}0^-) - (3^{--}0^-)$ waves

$\omega\eta$ ANALYSIS

A study of the $\omega\eta$ system is being carried out to search for possible hybrid states whose wavefunction can contain an $s\bar{s}$ component as well as $u\bar{u}(d\bar{d})$. Furthermore, Close and Page [3] suggest that for the predicted hybrid $(J^{PC}1^{--})$ $\omega(1800-2000)$, the flux-tube model favored P-wave + S-wave decay paths are kinematically suppressed, leaving $\rho\pi$ and $\omega\eta$ as the dominate decay modes. In addition, the $\omega\eta$ final state is particularly interesting since there have not been any confirmed reports of mesons decaying to $\omega\eta$ [4].

To reduce combinatorial background under the η, events with ambiguous 4γ fits to both $2\pi^o$ and $\pi^o\eta$ were removed. Figure 5a shows a sample of the eta signal in the $\gamma\gamma$ effective mass spectrum for events with one π^o selected. Figure 5b shows the mass spectrum for the three pions, vivid ω and η peaks are present. For an ω selection of $0.73 < \text{mass}(\pi^+\pi^-\pi^o) < 0.85$ GeV$/c^2$, the $\omega\eta$ mass spectrum in Figure 5c shows no obvious resonant structure.

A partial wave analysis of the $\omega\eta$ system is currently in progress. The fit favors an $IJ^{PC}01^{--}$ signal with a mass and width consistent with the $\omega(1600)$ [4] and an $IJ^{PC}01^{+-}$ signal at low mass.

REFERENCES

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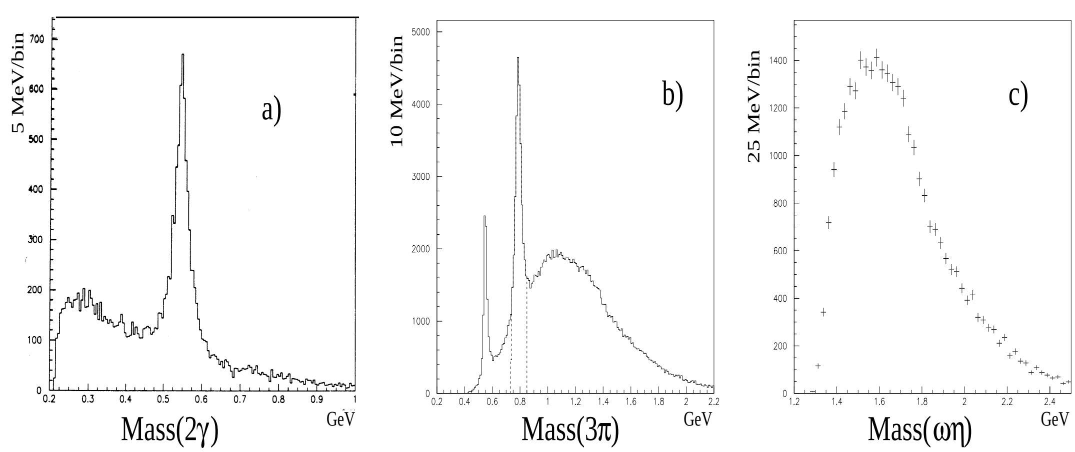

FIGURE 5. The accepted effective mass spectra for the $\eta\pi^+\pi^-\pi^o$ final meson state. a) $\eta \rightarrow 2\gamma$ effective mass b) $\pi^+\pi^-\pi^o$ effective mass c) $\omega\eta$ effective mass