Result J/ψ results from BESII

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Many decay modes of J/ψ channels are studied using 5.8 × 10^7 J/ψ events collected at BESII. The 1−− structure Y(2175) is observed in the decay of J/ψ → ηφf_0(980) and no significance signal exists in the decay of J/ψ → ηK^+0K^-0. The baryon pair processes of J/ψ → Σ^+Σ^- and J/ψ → Ξ^0Ξ^0, are measured for the first time. The branching ratio of J/ψ to PPη and PPη' are determined. The systems K^0S K^±π^∓ and K^+K^-π^0 associated with an ω (or φ), denoted as X(1440), are studied, and the mass, width and branching ratios (or upper limit at 90% C.L.) are obtained.

1 Introduction

Many decay modes of J/ψ are studied at the Beijing Electron Positron collider (BEPC). BEPC operates in the center of mass energy range from 2 to 5 GeV with a luminosity at the J/ψ energy of approximately 5 × 10^30 cm^{-2}s^{-1}. BES detector is described in Ref. 1.

The J/ψ and ψ(2S) has been useful for searches for new hadrons and studies of light hadron spectroscopy. A number of new results are obtained in J/ψ decays. After observing a new 1−− structure Y(2175) in the BABAR collaboration, Y(2175) is also observed in the decays of J/ψ → ηφf_0(980), with η → γγ, φ → K^+K^-, f_0(980) → π^+π^-3, but no evidence of Y(2175) exists in the decay of J/ψ → ηK^+0K^-0. The baryon pair processes of J/ψ → Σ^+Σ^- and J/ψ → Ξ^0Ξ^0 are measured for the first time. The branching ratios of J/ψ to PPη and PPη' are determined. The systems K^0S K^±π^∓ and K^+K^-π^0 associated with an ω have enhancements in the invariant mass distribution near 1.44 GeV/c^2, however no evidence for mass enhancement exits in the KKπ system recoiling against a φ.

2 Observation of Y(2175)

In the decays of J/ψ → ηφf_0(980), a clear η in the γγ mass, φ in the K^+K^- mass and f_0(980) signal in the π^+π^- mass are seen in Fig. 1 (a) (b) and (c). A peak around 2175 MeV/c^2 is observed in the φf_0(980) invariant mass of Figure (d). A fit with a Breit-Winger function gives the peak mass and width of m = 2.186 ± 0.010(stat) ± 0.006(syst) GeV/c^2 and Γ = 0.065 ± 0.023(stat) ± 0.017(syst) GeV/c^2 and the branching ratio is determined to be Br(J/ψ → ηY(2175)) · Br(Y(2175) → φf_0(980))Br(f_0(980) → π^+π^-) = (3.23 ± 0.75 ± 0.73) × 10^{-4}. 
This observation stimulated some theoretical speculation that this $J^{PC} = 1^{--}$ state may be an $s$-quark version of the $Y(4260)$ since both of them are produced in $e^+e^-$ annihilation and exhibit similar decay patterns. There have been a number of different interpretations proposed for the $Y(4260)$, including: a $c\bar{c}g$ hybrid; a $4^3S_1 c\bar{c}$ state; a $[cs][\bar{c}s]$ tetraquark state; or baryonium. Likewise a $Y(2175)$ has correspondingly been interpreted as: a $s\bar{s}g$ hybrid; a $2^3D_1 s\bar{s}$ state; or a $s\bar{s}s\bar{s}$ tetraquark state. As of now, none of these interpretations have either been established or ruled out by experiment. It is possible to distinguish the hybrid and higher quarkonium. So the decay $J/\psi \rightarrow \eta K^*\bar{K}^*$ which is forbidden if $Y(2175)$ is a hybrid state is also studied at BESII.

Figure 2 (a) (b) show $\gamma\gamma$ invariant mass and the scatter plot of $K^+\pi^-$ versus $K^-\pi^+$ after event selection, and a $K^{*0}(K^{*0})$ band and $\eta$ peak are obvious. Here the branching ratio of $Br(J/\psi \rightarrow \eta K^{*0}\bar{K}^{*0}) = (7.7 \pm 0.8(stat) \pm 1.4(syst)) \times 10^{-4}$ are measured for the first time. Figure (c) shows the invariant mass of $K^{*0}\bar{K}^{*0}$, no obvious signal of $Y(2175)$ exists and the upper limit of $Br(J/\psi \rightarrow \eta Y(2175)) \cdot Br(Y(2175) \rightarrow K^{*0}\bar{K}^{*0})$ at 90% C.L. is given to be $2.26 \times 10^{-4}$.

Figure 3 (a) (b) show the distribution of $\pi^0P$ and $\pi^0\bar{P}$, Two clear bumps corresponding to the signal $\Sigma^+$ and $\Sigma^-$. Figure 3 (c) shows the $\Sigma$ fitting with the signal shape from MC simulation together with second order polynomial for the background. Figure 4 (a) (b) show the distribution of $\pi^0\Lambda$ and $\pi^0\bar{\Lambda}$, Two clear bumps corresponding to the signal $\Xi^0$ and $\Xi^0$. Figure 4 (c) shows the $\Xi$ fitting results. Table 1 summarizes the measurement results for $J/\psi \rightarrow \Sigma^+\Sigma^-$ and $J/\psi \rightarrow \Xi^0\Xi^0$. We note that the isospin partners, $\Sigma^+$ and $\Sigma^0$ and also $\Xi^0$ and $\Xi^-$, have the similar branching fractions in agreement with the expectations of isospin symmetry. And

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**Figure 1:** (a) The $\gamma\gamma$ invariant mass. (b) The $K^+K^-$ invariant mass. (c) The $\pi^+\pi^-$ invariant mass. (d) The $\phi f_0(980)$ invariant mass.
Table 1: The branching fractions of $J/\psi$ decays into $\Sigma^+\Sigma^-$ and $J/\psi \to \Xi^0\Xi^0$.

<table>
<thead>
<tr>
<th>channels</th>
<th>$J/\psi \to \Sigma^0\Sigma^0$</th>
<th>$J/\psi \to \Xi^-\Xi^+$</th>
<th>$J/\psi \to \Sigma^+\Sigma^-$</th>
<th>$J/\psi \to \Xi^0\Xi^0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARKI</td>
<td>$1.3 \pm 0.4$</td>
<td>$1.4 \pm 0.5$</td>
<td></td>
<td>$3.2 \pm 0.8(\Xi^0\Xi^0 + \Xi^-\Xi^+)$</td>
</tr>
<tr>
<td>MARKII</td>
<td>$1.58 \pm 0.16 \pm 0.25$</td>
<td>$1.14 \pm 0.08 \pm 0.020$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM2</td>
<td>$1.06 \pm 0.04 \pm 0.23$</td>
<td>$1.4 \pm 0.12 \pm 0.24$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BESII</td>
<td>$1.33 \pm 0.04 \pm 0.11$</td>
<td>$1.50 \pm 0.10 \pm 0.22$</td>
<td>$1.20 \pm 0.12 \pm 0.21$</td>
<td></td>
</tr>
<tr>
<td>BarBar</td>
<td>$1.15 \pm 0.24 \pm 0.03$</td>
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combining of the corresponding $\psi(2S)$ branching fraction PQCD 12% rule holds within errors.

![Figure 3](image1.png)

Figure 3: (a) The $\pi^0 P$ invariant mass. (b) The $\pi^0 \bar{P}$ invariant mass. (c) The $\pi P$ invariant mass.

![Figure 4](image2.png)

Figure 4: (a) The $\pi^0 \Lambda$ invariant mass. (b) The $\pi^0 \bar{\Lambda}$ invariant mass. (c) The $\pi \Lambda$ invariant mass.

4 $J/\psi$ to $PP\eta$ and $PP\eta'$

The decay of $J/\psi \to PP\eta$ has been studied via $\eta \to \gamma \gamma$ and $\eta \to \pi^+\pi^-\pi^0$, and shown in Fig. 5 (a) (b), respectively. The decay of $J/\psi \to PP\eta'$ has been also measured through $\eta' \to \eta \pi^+\pi^-$ and $\eta' \to \gamma \rho$ in Fig. 5 (c) (d).

5 Observation $X(1440)$ in the decays $J/\psi \to \omega KK \pi$ and $J/\psi \to \phi KK \pi$

Figure 6 (a) (b) shows the $K^0_S K^\pm \pi^\mp$ and $K^+ K^- \pi^0$ invariant mass recoiling against the $\omega$. A peak around 1.44 GeV$^2$, denoted as $X(1440)$, is obvious. The mass, width, and branching fractions are obtained and listed in Table 3. Figure 6 (c) (d) show the $K^0_S K^\pm \pi^\mp$ and $K^+ K^- \pi^0$ invariant mass recoiling against the $\phi$. No significant structure $X(1440)$ exists and An upper limits on the $X(1440)$ decay branching fractions at the 90% C.L. are also given in Table 3.

6 Prospect

The BEPC (BEPCII) has been updated by government approval and BEPCII has a high luminosity double-ring collider. Many sub-detector has been greatly improved. Now BESIII has
Figure 5: (a) The fitting result of $\eta$ via $\eta \rightarrow \gamma \gamma$. (b) The fitting result of $\eta$ via $\eta \rightarrow \pi^+ \pi^- \pi^0$. (c) The fitting result of $\eta'$ via $\eta' \rightarrow \eta \pi^+ \pi^-$. (d) The fitting result of $\eta'$ via $\eta' \rightarrow \gamma \rho$.

Table 2: The branching fractions of $J/\psi$ decays into $P\bar{P}\eta(\eta')$.

<table>
<thead>
<tr>
<th>decays</th>
<th>$\text{Br}(10^{-3})$ (this work)</th>
<th>PDG value ($10^{-3}$)</th>
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<tr>
<td>$P\bar{P}\eta(\eta \rightarrow \gamma \gamma)$</td>
<td>$1.81 \pm 0.02 \pm 0.16$</td>
<td>$2.09 \pm 0.18$</td>
</tr>
<tr>
<td>$P\bar{P}\eta(\eta \rightarrow \pi^+ \pi^- \pi^0)$</td>
<td>$1.77 \pm 0.08 \pm 0.25$</td>
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<tr>
<td>$P\bar{P}\eta'(\eta' \rightarrow \eta \pi^+ \pi^-)$</td>
<td>$0.225 \pm 0.039 \pm 0.040$</td>
<td>$0.9 \pm 0.4$</td>
</tr>
<tr>
<td>$P\bar{P}\eta'(\eta' \rightarrow \gamma \rho)$</td>
<td>$0.199 \pm 0.025 \pm 0.033$</td>
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Table 3: The mass, width, and branching fractions of $J/\psi$ decays into $\{\omega, \phi\}X(1440)$.

<table>
<thead>
<tr>
<th>$J/\psi \rightarrow \omega X(1440)$</th>
<th>$J/\psi \rightarrow \omega X(1440)$</th>
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<tbody>
<tr>
<td>$(X \rightarrow K^0_SK^+K^-\pi^- + \text{c.c.})$</td>
<td>$(X \rightarrow K^+K^-\pi^0)$</td>
</tr>
<tr>
<td>$M = 1437.6 \pm 3.2$ MeV/$c^2$</td>
<td>$M = 1445.9 \pm 5.7$ MeV/$c^2$</td>
</tr>
<tr>
<td>$\Gamma = 48.9 \pm 9.0$ MeV/$c^2$</td>
<td>$\Gamma = 34.2 \pm 18.5$ MeV/$c^2$</td>
</tr>
<tr>
<td>$B(J/\psi \rightarrow \omega X(1440) \rightarrow \omega K^0_SK^+K^-\pi^- + \text{c.c.})$</td>
<td>$= (4.86 \pm 0.69 \pm 0.81) \times 10^{-4}$</td>
</tr>
<tr>
<td>$B(J/\psi \rightarrow \omega X(1440) \rightarrow \omega K^+K^-\pi^0)$</td>
<td>$= (1.92 \pm 0.57 \pm 0.38) \times 10^{-4}$</td>
</tr>
<tr>
<td>$B(J/\psi \rightarrow \phi X(1440) \rightarrow \phi K^0_SK^+K^-\pi^- + \text{c.c.})$</td>
<td>$&lt; 1.93 \times 10^{-5}$ (90% C.L.)</td>
</tr>
<tr>
<td>$B(J/\psi \rightarrow \phi X(1440) \rightarrow \phi K^+K^-\pi^0)$</td>
<td>$&lt; 1.71 \times 10^{-5}$ (90% C.L.)</td>
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</tbody>
</table>
achieved new peak luminosity of $1.85 \times 10^{32} \text{cm}^{-2}\text{s}^{-1}$ and taking $\psi(2S)$ data. We’re expecting new exciting results at BESIII.