Recent Charmonium Physics from BES

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Measurements of branching fractions for $\psi(2S)$ decays into $\omega \pi^+ \pi^-$, $b_1 \pi$, $\omega f_2(1270)$, $\omega K^+ K^-$, $\omega \phi$, $\phi \pi^+ \pi^-$, $\phi f_0(980)$, $\phi K^+ K^-$, and $\phi \eta$ final states, based on a data sample of $(4.02 \pm 0.22) \times 10^6 \psi(2S)$ events collected with the BESI detector at the Beijing Electron-Positron Collider, are reported. Using the same event sample, radiative decays of the radially excited charmonium resonance, $\psi(2S)$, into $\pi \pi$, $KK$ and $\eta \eta$ final states have been measured. The branching ratios $B(\psi(2S) \rightarrow \gamma f_0(1270)) = (2.12 \pm 0.19 \pm 0.32) \times 10^{-4}$ and $B(\psi(2S) \rightarrow \gamma f_0(1710)) \times B(f_0(1710) \rightarrow K^+ K^-) = (3.02 \pm 0.45 \pm 0.66) \times 10^{-5}$ are obtained.

Cross sections for $e^+e^- \rightarrow e^+e^-$, hadrons, $\pi^+ \pi^- J/\psi$, and $\mu^+ \mu^-$ have been measured in the vicinity of the $\psi(2S)$ resonance using the BESII detector. The $\psi(2S)$ total width; partial widths to hadrons, $\pi^+ \pi^- J/\psi$, and muons; and corresponding branching fractions have been determined to be $\Gamma_1 = 264 \pm 27$ keV; $\Gamma_h = 258 \pm 26$ keV, $\Gamma_{\mu} = 2.44 \pm 0.21$ keV, and $\Gamma_{\pi^+ \pi^- J/\psi} = 85.4 \pm 8.7$ keV; and $B_h = (97.79 \pm 0.15)\%$, $B_{\pi^+ \pi^- J/\psi} = (32.3 \pm 1.4)\%$, $B_{\mu} = (0.93 \pm 0.08)\%$, respectively.

Decays of $J/\psi \rightarrow \gamma \eta_c$ are used to determine the mass and width of the $\eta_c$ using a sample of 58 $J/\psi$ events: $M_{\eta_c} = (2977.5 \pm 1.0 \pm 1.2)$ MeV and $\Gamma_{\eta_c} = (17.0 \pm 3.7 \pm 7.4)$ MeV.

The first observation of $\chi_{cJ}$ ($J=0,1,2$) decays to $\Lambda \bar{\Lambda}$ is reported using $\psi(2S)$ data collected with the BESI detector at the BEPC. The branching ratios are determined to be $B(\chi_{c0} \rightarrow \Lambda \bar{\Lambda}) = (4.7^{+1.3}_{-1.2} \pm 1.0) \times 10^{-4}$, $B(\chi_{c1} \rightarrow \Lambda \bar{\Lambda}) = (2.6^{+1.6}_{-0.9} \pm 0.6) \times 10^{-4}$ and $B(\chi_{c2} \rightarrow \Lambda \bar{\Lambda}) = (3.3^{+1.5}_{-1.3} \pm 0.7) \times 10^{-4}$. Results are compared with model predictions.

§1. Introduction

The Beijing Spectrometer (BES) is a general purpose solenoidal detector 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 $J/\psi$ energy of approximately $5 \times 10^{30}$ cm$^{-2}$s$^{-1}$. BES (BESI) is described in detail in Ref. 1), and the upgraded BES detector (BESII) is described in Ref. 2). This paper presents some recent results; details can be found in the references.

§2. Hadronic $\psi(2S)$ decays

Both $J/\psi$ and $\psi(2S)$ decays to light hadrons are expected to proceed dominantly via $\psi \rightarrow ggg$, with widths that are proportional to the square of the $c\bar{c}$ wave function at the origin.\(^3\)

This yields the expectation that

$$Q_X = \frac{B(\psi(2S) \rightarrow X_h)}{B(J/\psi \rightarrow X_h)} \approx \frac{B(\psi(2S) \rightarrow e^+e^-)}{B(J/\psi \rightarrow e^+e^-)} \approx 12\%$$
It was first observed by MarkII\textsuperscript{4}) that the vector-pseudoscalar $\rho \pi$ and $K^*\overline{K}$ channels are suppressed with respect to the 12% expectation - the "$\rho \pi$ puzzle". BES finds a $\rho \pi$ suppression factor of $\sim 60$; this and many other BES $\psi(2S)$ branching ratio results can be found in Refs. 5)-9).

Here, we report measurements of branching fractions for $\psi(2S)$ decays involving an $\omega$ or a $\phi$, including $\omega \pi^+\pi^-$, $b_1\pi$, $\omega f_2(1270)$, $\omega K^+K^-$, $\omega pp$, $\phi\pi^+\pi^-$, $\phi f_0(980)$, $\phi K^+K^-$, and $\phi pp$ final states, based on a data sample of $(4.02 \pm 0.22) \times 10^6 \psi(2S)$ events collected with the BESI detector at the Beijing Electron-Positron Collider. Events are selected using particle identification and kinematic fitting. As an example, the $K^+K^-$ invariant mass distribution for candidate $\psi(2S) \rightarrow \phi\pi^+\pi^-$ events is shown in Fig. 1, where a clear $\phi$ peak can be seen. In Fig. 2, the $\pi^+\pi^-\pi^0$ mass distribution for $\psi(2S) \rightarrow \omega K^+K^-$ events is shown; there is a clear $\omega$ peak. We obtain the branching ratios and $Q_X$ values shown in Table I. The branching fractions for $b_1\pi$ and $\omega f_2(1270)$ update previous BES results, while those for other decay modes are first measurements. The ratios of $\psi(2S)$ and $J/\psi$ branching fractions are smaller than the expected 12% rule by a factor of six for $\omega f_2(1270)$, by a factor of two for $\omega \pi^+\pi^-$, $\omega pp$, and $\phi K^+K^-$, while for other studied channels the ratios are consistent with expectations within errors. For more detail on this analysis, see Ref. 11).

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
Channel & $B_{\psi(2S) \rightarrow X}$ & $Q_X(\%)$ \\
\hline
$X$ & $(10^{-4})$ & \\
\hline
$\omega \pi^+\pi^-$ & 4.8 $\pm$ 0.6 $\pm$ 0.7 & 6.7 $\pm$ 1.7 \\
$\phi b_1\pi$ & 3.2 $\pm$ 0.6 $\pm$ 0.5 & 11 $\pm$ 3 \\
$\omega f_2(1270)$ & 1.1 $\pm$ 0.5 $\pm$ 0.2 & 2.4 $\pm$ 1.3 \\
$\omega K^+K^-$ & & $< 1.5$ \\
$\omega pp$ & 0.8 $\pm$ 0.3 $\pm$ 0.1 & 6.0 $\pm$ 2.8 \\
$\phi \pi^+\pi^-$ & 1.5 $\pm$ 0.2 $\pm$ 0.2 & 18 $\pm$ 5 \\
$\phi f_0(980) \times (f_0 \rightarrow \pi^+\pi^-)$ & 0.6 $\pm$ 0.2 $\pm$ 0.1 & \\
$\phi f_0(980)$ & 1.1 $\pm$ 0.4 $\pm$ 0.1 & 33 $\pm$ 15 \\
$\phi K^+K^-$ & 0.6 $\pm$ 0.2 $\pm$ 0.1 & 7.3 $\pm$ 2.6 \\
$\phi pp$ & $< 0.26$ & $< 0.58$ \\
\hline
\end{tabular}
\caption{Branching fractions of $\psi(2S)$ and $Q_X$ values for $\psi(2S)$ and $J/\psi$ hadronic decays. The $B_{J/\psi}$ are taken from the PDG.\textsuperscript{10}) To determine $B(\phi f_0(980))$, we use $B_{f_0 \rightarrow \pi^+\pi^-} = 0.521 \pm 0.016$ (PDG’96).}
\end{table}

Fig. 1. The $K^+K^-$ invariant mass distribution for candidate $\psi(2S) \rightarrow \phi\pi^+\pi^-$ events.

Fig. 2. The $\pi^+\pi^-\pi^0$ mass distribution for candidate $\psi(2S) \rightarrow \omega K^+K^-$ events.

In perturbative QCD, the radiative $J/\psi$ and $\psi(2S)$ decays should be similar to hadronic decays except instead of decaying into three gluons, the radiative mode
decays via two gluons and one photon. Thus one power of the coefficient $\alpha_S$ is replaced by $\alpha_{QED}$ in the cross section formula, and it is expected that the “12%” rule should also work for radiative decay modes\textsuperscript{12}. Hence the ratio of $B(\psi(2S) \rightarrow \gamma X)$ to $B(J/\psi \rightarrow \gamma X)$ for different final states $X$ should be roughly 12%.

Fig. 3. (a): $M_{\pi^+\pi^-}$ fit result. The four curves presented in the figure are the following: a background curve, a Breit-Wigner function to describe the $f_2(1270)$ on top of the background, a Breit-Wigner function to describe the $f_0(1710)$ on top of the background, and the total of the two Breit-Wigners and the background. The fitting range is 0.9 GeV to 2.5 GeV, since there is some $\rho$ background below 0.9 GeV. The background at higher mass is due to processes such as $\psi(2S) \rightarrow$ neutrals $J/\psi$, $J/\psi \rightarrow \pi^+\pi^-\pi^0$. (b): $M_{\pi^0\pi^0}$ fit result. The curves shown are a Breit-Wigner to describe the $f_2(1270)$ and a polynomial to describe the background. Here we report measurements of branching fractions for $\psi(2S) \rightarrow \gamma\pi^+\pi^-$, $\gamma\pi^0\pi^0$, $\gamma K^+K^-$, $\gamma K^0_S K^0_S$, and $\gamma\eta\eta$. The $\pi\pi$ invariant mass distributions for $\psi(2S) \rightarrow \gamma\pi\pi$ are shown in Fig. 3, where a clear $f_2(1270)$ is seen. Results are summarized in Tables II through IV. First measurements of the $\psi(2S) \rightarrow \gamma f_2(1270)$ and $\psi(2S) \rightarrow \gamma f_0(1710) \rightarrow \gamma K^+K^-$ and $\gamma K^0_S K^0_S$ branching fractions are given. A clear $f_0(1710)$ signal in $\psi(2S)$ radiative decay into $K^+K^-$ final states is observed. The results are consistent with the “12%” rule. In addition, first measurements of the branching fractions of $\chi_{c0}$ and $\chi_{c2}$ decay into $\pi^0\pi^0$, $\chi_{c0}$ decay into $\eta\eta$, and an upper limit of the branching fraction of $\chi_{c2}$ decay into $\eta\eta$ are reported (see Table IV). For more detail, see Ref. 13.

| Final state | $B(\psi(2S) \rightarrow \gamma f_2(1270)) \times 10^{-4}$ | $B(\psi(2S))/B(J/\psi)$ |
|-------------|---------------------------------|--------------------------|
| $\gamma f_2(1270)$ | 2.12 ± 0.19 ± 0.32 | (15.4 ± 3.1)% |
| $\gamma f_0(1710) \rightarrow \gamma K^+K^-$ | 0.302 ± 0.045 ± 0.066 | (7.1^{+2.1}_{-2.0})% |

Table II. Values for $B(\psi(2S) \rightarrow \gamma f_2(1270))$ and $B(\psi(2S) \rightarrow \gamma f_0(1710) \rightarrow \gamma K^+K^-)$ and comparison with the 12% rule.
The total integrated luminosity was 760 fb$^{-1}$ between 3.67 and 3.71 GeV were scanned.

In 1999, after the $R$-scan, BES did a careful $\psi(2S)$ scan. The purpose was to improve the accuracies of the $\psi(2S)$ parameters: the total width ($\Gamma_t$), and partial widths into hadrons ($\Gamma_h$), $\mu^+\mu^-$ ($\Gamma_{\mu}$), and $\pi^+\pi^-J/\psi$ ($\Gamma_{\pi^+\pi^-J/\psi}$), and the corresponding branching fractions, $B(h)$, $B(\mu)$, and $B(\pi^+\pi^-J/\psi)$. $B(\pi^+\pi^-J/\psi)$ and $B(\mu)$ are important because these decays are used to identify $\psi(2S)$ in $B$ decays ($B \to \psi(2S)K_S^0$).

A total of 24 energy points between 3.67 and 3.71 GeV were scanned. The total integrated luminosity was 760 nb$^{-1}$. We assume $\Gamma_t = \Gamma_h + \Gamma_{\mu} + \Gamma_{\pi^+\pi^-J/\psi}$, along with lepton universality: $\Gamma_{\mu} = \Gamma_{\tau} = \Gamma_{\tau}/0.38847$. The cross sections versus scan point energy and fit curves are shown in Fig. 4, and the fit results are given in Table V. We obtain a first measurement of $\Gamma_{\pi^+\pi^-J/\psi}$, and $B(h)$, $B(\mu)$, and $B(\pi^+\pi^-J/\psi)$ have improved precision compared to the PDG values. The value for $\Gamma_t$ agrees within errors with a previous BES value of $(252 \pm 37)$ keV. A complete description of this work can be found in Ref. 16.

| Mode | $B(\times10^{-4})$ |
|------|-------------------|
| $\psi(2S) \to \gamma f_2(1270)$ from $\gamma\pi^+\pi^-$ | 2.08 ± 0.19 ± 0.33 |
| $\psi(2S) \to \gamma f_2(1270)$ from $\gamma\pi^0\pi^0$ | 2.90 ± 1.08 ± 1.07 |
| $\psi(2S) \to \gamma f_2(1270)$ from $\gamma\pi\pi$ | 2.12 ± 0.19 ± 0.32 |
| $\psi(2S) \to \gamma f_0(1710) \to \gamma\pi\pi$ from $\gamma\pi^+\pi^-$ | 0.301 ± 0.041 ± 0.124 |
| $\psi(2S) \to \gamma f_0(1710) \to \gamma K^+K^-$ | 0.302 ± 0.045 ± 0.066 |
| $\psi(2S) \to \gamma f_0(1710) \to \gamma K_S^0K_S^0$ | 0.206 ± 0.094 ± 0.108 |

Table III. Branching fractions for $\psi(2S) \to \gamma X \to \gamma PP$ modes ($P$ stands for pseudo-scalar).

| Mode | $B(\times10^{-4})$ | $B \times B(\psi(2S) \to \gamma\chi_{c0,2}) (\times10^{-4})$ |
|------|-------------------|--------------------------------------------------|
| $\chi_{c0} \to \pi^0\pi^0$ | 2.79 ± 0.32 ± 0.57 | 2.42 ± 0.28 ± 0.44 |
| $\chi_{c2} \to \pi^+\pi^-\gamma$ | 0.98 ± 0.27 ± 0.56 | 0.67 ± 0.19 ± 0.38 |
| $\chi_{c0} \to \eta\eta$ | 2.02 ± 0.84 ± 0.59 | 1.76 ± 0.73 ± 0.49 |
| $\chi_{c2} \to \eta\eta$ | < 1.37 | < 0.93 |

Table IV. The $\chi_c$ decay branching fractions for $\chi_{c0,2} \to \pi^0\pi^0$ or $\eta\eta$.

§3. BES $\psi(2S)$ Scan Results

Fig. 4. The cross section for (a) $e^+e^- \to$ hadrons, (b) $e^+e^- \to \pi^+\pi^-J/\psi$, and (c) $e^+e^- \to \mu^+\mu^-$ versus center-of-mass energy. The solid curves represent the results of the fit to the data.
§4. \( \eta_c \) Parameters

The mass and width of the \( \eta_c \) are rather poorly known; the confidence level for the PDG weighted average mass is only 0.001.\(^{10} \) Previously BES measured the \( \eta_c \) mass using the BESI 4.02 M \( \psi(2S) \) sample and obtained \( M_{\eta_c} = (2975.8 \pm 3.9 \pm 1.2) \text{ MeV} \).\(^{17} \) BES also used 7.8 M BESI \( J/\psi \) events and obtained \( M_{\eta_c} = (2976.6 \pm 2.9 \pm 1.3) \text{ MeV} \).\(^{18} \) For the two data sets combined, \( M_{\eta_c} = (2976.3 \pm 2.3 \pm 1.2) \text{ MeV} \) and the total width \( \Gamma_{\eta_c} = (11.0 \pm 8.1 \pm 4.1) \text{ MeV} \).\(^{18} \)

Here, the mass and width have been determined using our BESII 58 M \( J/\psi \) event sample. We use the channels \( J/\psi \to \gamma \eta_c \), with \( \eta_c \to p\bar{p}, K^+K^-\pi^+\pi^- , \pi^+\pi^-\pi^+\pi^- , K^\pm K^\mp \pi^\mp , \) and \( \phi\phi \). Events are selected using particle identification and kinematic fitting. Figs. 5 and 6 show the mass distributions in the \( \eta_c \) mass region for \( J/\psi \to \gamma \eta_c \), \( \eta_c \to p\bar{p} \) and \( \eta_c \to K^+K^-\pi^+\pi^- \), respectively. Combining the five decay channels, we obtain \( M_{\eta_c} = (2977.5 \pm 1.0 \pm 1.2) \text{ MeV} \) and \( \Gamma_{\eta_c} = (17.0 \pm 3.7 \pm 7.4) \text{ MeV} \), to be compared to the current PDG values: \( M_{\eta_c} = (2979.7 \pm 1.5) \text{ MeV} \) and \( \Gamma_{\eta_c} = (16.0^{+3.6}_{-3.2}) \text{ MeV} \).\(^{10} \) The results for the mass and width are compared with previous measurements, including previous BES measurements, in Figs. 7 and 8. The results are in good agreement with previous BES measurements and the PDG fit values. More detail on this analysis can be found in Ref. 19).

\[
\begin{array}{|c|c|c|}
\hline
\text{Value} & \text{BES} & \text{PDG2002} \\
\hline
\Gamma_t (\text{keV}) & 264 \pm 27 & 300 \pm 25 \\
\Gamma_h (\text{keV}) & 258 \pm 26 & \\
\Gamma_{\pi\pi J/\psi} (\text{keV}) & 85.4 \pm 8.7 & \\
\Gamma_{\mu} (\text{keV}) & 2.44 \pm 0.21 & \\
B_t(\%) & 97.79 \pm 0.15 & 98.10 \pm 0.30 \\
B_{\pi\pi J/\psi}(\%) & 32.3 \pm 1.4 & 30.5 \pm 1.6 \\
B_{\mu}(\%) & 0.93 \pm 0.08 & 0.7 \pm 0.09 \\
\hline
\end{array}
\]

Table V. \( \psi(2S) \) scan results and comparison with the PDG2002.\(^{10} \) \( \Gamma_t \) value given using the assumption \( \Gamma_e = \Gamma_{\mu} \).

§5. \( \chi J \to \Lambda \bar{\Lambda} \)

It has been shown both in theoretical calculations and experimental measurements that the lowest Fock state expansion (color singlet mechanism, CSM) of char-
monium states is insufficient to describe P-wave quarkonium decays. Instead, the next higher Fock state (color octet mechanism, COM) plays an important role.\(^\text{20, 21}\) Our earlier measurement\(^\text{21}\) of the total width of the \(\chi_{c0}\) agrees rather well with the COM expectation. The calculation of the partial width of \(\chi_{cJ} \rightarrow p\bar{p}\), by taking into account the COM of \(\chi_{cJ}\) decays and using a carefully constructed nucleon wave function,\(^\text{22}\) obtains results in reasonable agreement with measurements.\(^\text{10}\) The nucleon wave function was then generalized to other baryons, and the partial widths of many other baryon anti-baryon pairs predicted. Among these predictions, the partial width of \(\chi_{cJ} \rightarrow \Lambda\bar{\Lambda}\) is about half of that of \(\chi_{cJ} \rightarrow p\bar{p}\) (\(J=1,2\)).\(^\text{22}\)
clear $\Lambda \bar{\Lambda}$ signal. Selecting events in $\chi_{cJ}$ mass region and requiring the mass of $\pi^+ p$ ($\pi^- p$) to be smaller than 1.15 GeV/$c^2$, the $\pi^- p$ ($\pi^+ p$) mass distribution shown in Fig. 10 is obtained. A clear $\Lambda$ signal can be seen, and the background below the peak is very small.

After requiring that both the $\pi^+ p$ and the $\pi^- p$ mass lie within twice the mass resolution around the nominal $\Lambda$ mass, the $\Lambda \bar{\Lambda}$ invariant mass distribution shown in Fig. 11 is obtained. There are clear $\chi_{c0}$, $\chi_{c1}$, and $\chi_{c2} \rightarrow \Lambda \bar{\Lambda}$ signals. The highest peak around the $\psi(2S)$ mass is due to $\psi(2S) \rightarrow \Lambda \bar{\Lambda}$ with a fake photon.

Background from non $\Lambda \bar{\Lambda}$ events is estimated from the $\Lambda$ mass sidebands, and this can be described in fitting the $\Lambda \bar{\Lambda}$ mass spectrum by a linear background. The background from channels with $\Lambda \bar{\Lambda}$ production, including $\psi(2S) \rightarrow \Lambda \bar{\Lambda}$, $\psi(2S) \rightarrow \Sigma^0 \Sigma^0$, $\psi(2S) \rightarrow \Lambda \bar{\Lambda} + c.c.$, $\psi(2S) \rightarrow \Xi^0 \Xi^0 + c.c.$, $\psi(2S) \rightarrow \gamma\chi_{cJ}$, $\chi_{cJ} \rightarrow \Sigma^0 \Sigma^0 \rightarrow \gamma\gamma \Lambda \bar{\Lambda}$, and $\psi(2S) \rightarrow \pi^+ \pi^- J/\psi \rightarrow \pi^+ \pi^- p\bar{p}$, are simulated by Monte Carlo.

Fixing the $\chi_{c0}$, $\chi_{c1}$ and $\chi_{c2}$ mass resolutions at their Monte Carlo predicted values, and fixing the widths of the three $\chi_{cJ}$ states to their world average values, $^{10}$ the mass spectrum (Fig. 11) was fit with three Breit-Wigner functions folded with Gaussian resolutions and background, including a linear term representing the non $\Lambda \bar{\Lambda}$ background and a component representing the $\Lambda \bar{\Lambda}$ background. The unbinned maximum likelihood method was used to fit the events with $\Lambda \bar{\Lambda}$ mass between 3.22 and 3.64 GeV/$c^2$, and a likelihood probability of 27% was obtained, indicating a reliable fit. Fig. 11 shows the fit result, and the fitted masses are $(3425.6 \pm 6.3)$ MeV/$c^2$, $(3508.5 \pm 3.9)$ MeV/$c^2$ and $(3560.3 \pm 4.6)$ MeV/$c^2$ for $\chi_{c0}$, $\chi_{c1}$ and $\chi_{c2}$, respectively, in agreement with the world average values. $^{10}$ The branching ratios of $\chi_{cJ} \rightarrow \Lambda \bar{\Lambda}$ obtained are

$$B(\chi_{c0} \rightarrow \Lambda \bar{\Lambda}) = (4.7^{+1.3}_{-1.2} \pm 1.0) \times 10^{-4},$$

$$B(\chi_{c1} \rightarrow \Lambda \bar{\Lambda}) = (2.6^{+1.0}_{-0.9} \pm 0.6) \times 10^{-4},$$

$$B(\chi_{c2} \rightarrow \Lambda \bar{\Lambda}) = (3.3^{+1.5}_{-1.3} \pm 0.7) \times 10^{-4},$$

where the first errors are statistical and the second are systematic.

Compared with the corresponding branching ratios of $\chi_{cJ} \rightarrow p \bar{p}$, $^{10}$ the branching ratios of $\chi_{c1}$ and $\chi_{c2} \rightarrow \Lambda \bar{\Lambda}$ agree with the corresponding branching ratios to $p \bar{p}$ within two sigma. This is somewhat in contradiction with the expectations from Ref. 22), although the errors are large.
As for $\chi_{c0} \to \Lambda\bar{\Lambda}$, the measured value agrees with the $p\bar{p}$ measurements from BES and E835 within 2 standard deviations. One should also note that there is no prediction for $\mathcal{B}(\chi_{c0} \to \Lambda\bar{\Lambda})$. More detail may be found in Ref. 24.

§6. Summary

Branching fractions are determined, many for the first time, using the 4.2 million BESI $\psi(2S)$ event sample. They are used to test the “12 %” rule. Results from a fit to a careful scan in the vicinity of the $\psi(2S)$ are presented. The 58 million BESII $J/\psi$ event sample is used to measure the mass and width of the $\eta_c$. Finally, $\Lambda\bar{\Lambda}$ events are observed for the first time in $\chi_{cJ}$ decays using the BESII 15 million $\psi(2S)$ event sample, and corresponding branching ratios are determined.

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