\[ \eta_c(2S) \]

\[ i G(J^P_C) = 0^+(0^-) \]

Quantum numbers are quark model predictions.

### \( \eta_c(2S) \) MASS

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>EVTS</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3639.4 \pm 1.3) OUR AVERAGE</td>
<td></td>
<td></td>
<td></td>
<td>Error includes scale factor of 1.2.</td>
</tr>
<tr>
<td>(3646.9 \pm 1.6 \pm 3.6)</td>
<td>57 ± 17</td>
<td>ABLIKIM 13k BES3</td>
<td></td>
<td>(\psi(2S) \rightarrow \gamma K^0_S K^+ \pi^+ \pi^-)</td>
</tr>
<tr>
<td>(3637.6 \pm 2.9 \pm 1.6)</td>
<td>127 ± 18</td>
<td>1 ABLIKIM 12G BES3</td>
<td></td>
<td>(\psi(2S) \rightarrow \gamma K^0 K\pi),</td>
</tr>
<tr>
<td>(3638.5 \pm 1.5 \pm 0.8)</td>
<td>624</td>
<td>2 DEL-AMO-SA..11m BABR</td>
<td></td>
<td>(KK^0 \rightarrow K^0 K^+ \pi^\mp)</td>
</tr>
<tr>
<td>(3640.5 \pm 3.2 \pm 2.5)</td>
<td>1201</td>
<td>2 DEL-AMO-SA..11m BABR</td>
<td></td>
<td>(\gamma \gamma \rightarrow K^+ K^- \pi^+ \pi^- \pi^0)</td>
</tr>
<tr>
<td>(3636.1 \pm 3.9 \pm 0.7)</td>
<td>128</td>
<td>3 VINOKUROVA 11 BELL</td>
<td></td>
<td>(B^\pm \rightarrow K^\pm (K^0_S K^\pm \pi^\pm))</td>
</tr>
<tr>
<td>(3626)</td>
<td>311</td>
<td>4 ABE 07 BELL</td>
<td></td>
<td>(e^+ e^- \rightarrow J/\psi (c\bar{c}))</td>
</tr>
<tr>
<td>(3645.0 \pm 5.5 \pm 4.9)</td>
<td>121 ± 27</td>
<td>AUBERT 05C BABR</td>
<td></td>
<td>(K^+ K^- \pi^0)</td>
</tr>
<tr>
<td>(3642.9 \pm 3.1 \pm 1.5)</td>
<td>61</td>
<td>ASNER 04 CLEO</td>
<td></td>
<td>(\gamma \gamma \rightarrow \eta_c \rightarrow K^0_S K^\pm \pi^\mp)</td>
</tr>
</tbody>
</table>

1 From a simultaneous fit to \(K^0_S K^\pm \pi^\pm\) and \(K^+ K^- \pi^0\) decay modes.
2 Ignoring possible interference with continuum.
3 Accounts for interference with non-resonant continuum.
4 From a fit of the \(J/\psi\) recoil mass spectrum. Supersedes ABE,K 02 and ABE 04G.
5 From the fit of the kaon momentum spectrum. Systematic errors not evaluated.
6 Superseded by DEL-AMO-SANCHEZ 11M.
7 Superseded by VINOKUROVA 11.
8 Assuming mass of \(\psi(2S) = 3686\ MeV\).

### \( \eta_c(2S) \) WIDTH

<table>
<thead>
<tr>
<th>VALUE (MeV)</th>
<th>CL%</th>
<th>EVTS</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(11.3^+)</td>
<td>3.2^+</td>
<td>2.9^+</td>
<td>OUR AVERAGE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9.9 \pm 4.8 \pm 2.9)</td>
<td>57 ± 17</td>
<td>ABLIKIM 13k BES3</td>
<td></td>
<td>(\psi(2S) \rightarrow \gamma K^0_S K^+ \pi^+ \pi^-)</td>
<td></td>
</tr>
<tr>
<td>(16.9 \pm 6.4 \pm 4.8)</td>
<td>127 ± 18</td>
<td>9 ABLIKIM 12G BES3</td>
<td></td>
<td>(\psi(2S) \rightarrow \gamma K^0 K\pi),</td>
<td></td>
</tr>
<tr>
<td>(13.4 \pm 4.6 \pm 3.2)</td>
<td>624</td>
<td>10 DEL-AMO-SA..11m BABR</td>
<td></td>
<td>(\gamma \gamma \rightarrow K^0_S K^\pm \pi^\mp)</td>
<td></td>
</tr>
<tr>
<td>(6.6^+ \pm 8.4 \pm 2.6)</td>
<td>128</td>
<td>11 VINOKUROVA 11 BELL</td>
<td></td>
<td>(B^\pm \rightarrow K^\pm (K^0_S K^\pm \pi^\pm))</td>
<td></td>
</tr>
<tr>
<td>(6.3\pm 12.4 \pm 4.0)</td>
<td>61</td>
<td>ASNER 04 CLEO</td>
<td></td>
<td>(\gamma \gamma \rightarrow \eta_c \rightarrow K^0_S K^\pm \pi^\mp)</td>
<td></td>
</tr>
</tbody>
</table>
We do not use the following data for averages, fits, limits, etc.

< 23 90 98 ± 52 12 AUBERT 06 E BABR $B^± \rightarrow K^± X_c\pi$
< 22 ± 14 121 ± 27 AUBERT 05C BABR $e^+ e^- \rightarrow J/\psi \pi^\pm$
17.0 ± 8.3 ± 2.5 112 ± 24 13 AUBERT 04D BABR $\gamma\gamma \rightarrow \eta_c(2S) \rightarrow K\bar{K}\pi$
< 55 90 39 ± 11 14 CHOI 02 BELL $B \rightarrow K\bar{K}S K^− π^0$
< 8.0 95 15 EDWARDS 82C CBAL $e^+ e^- \rightarrow γ X$

9 From a simultaneous fit to $K_S^0 K^± π^\mp$ and $K^+ K^− π^0$ decay modes.
10 Ignoring possible interference with continuum.
11 Accounts for interference with non-resonant continuum.
12 From the fit of the kaon momentum spectrum. Systematic errors not evaluated.
13 Superseded by DEL-AMO-SANCHEZ 11M.
14 For a mass value of 3654 ± 6 MeV. Superseded by VINOKUROVA 11.
15 For a mass value of 3594 ± 5 MeV

**$η_c(2S)$ DECAY MODES**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Fraction ($Γ_j/Γ$)</th>
<th>Confidence level</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Γ_1$</td>
<td>hadrons</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_2$</td>
<td>$K\bar{K}\pi$</td>
<td>(1.9±1.2) %</td>
</tr>
<tr>
<td>$Γ_3$</td>
<td>$2π^+ 2π^−$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_4$</td>
<td>$ρ^0 ρ^0$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_5$</td>
<td>$3π^+ 3π^−$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_6$</td>
<td>$K^+ K^− π^+ π^−$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_7$</td>
<td>$K^0 K^*0$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_8$</td>
<td>$K^+ K^− π^+ π^− π^0$</td>
<td>(1.4±1.0) %</td>
</tr>
<tr>
<td>$Γ_9$</td>
<td>$K^+ K^− 2π^+ 2π^−$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_{10}$</td>
<td>$K^0 SK^− 2π^+ π^− + c.c.$</td>
<td>seen</td>
</tr>
<tr>
<td>$Γ_{11}$</td>
<td>$2K^+ 2K^−$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_{12}$</td>
<td>$ϕ ϕ$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_{13}$</td>
<td>$ρ ρ$</td>
<td>&lt; 2.0 $× 10^{-3}$ 90%</td>
</tr>
<tr>
<td>$Γ_{14}$</td>
<td>$γ γ$</td>
<td>(1.9±1.3) $× 10^{-4}$</td>
</tr>
<tr>
<td>$Γ_{15}$</td>
<td>$π^+ π^− \eta$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_{16}$</td>
<td>$π^+ π^− \eta'$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_{17}$</td>
<td>$K^+ K^− \eta$</td>
<td>not seen</td>
</tr>
<tr>
<td>$Γ_{18}$</td>
<td>$π^+ π^− \eta_c(15)$</td>
<td>&lt; 25 % 90%</td>
</tr>
</tbody>
</table>

**$η_c(2S)$ PARTIAL WIDTHS**

<table>
<thead>
<tr>
<th>Γ</th>
<th>Γ14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value (keV)</td>
<td>DOCUMENT ID</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1.3±0.6</td>
<td>16 ASNER 04 CLEO</td>
</tr>
</tbody>
</table>

Citation: K.A. Olive et al. (Particle Data Group), Chin. Phys. C38, 090001 (2014) (URL: http://pdg.lbl.gov)
They measure $\Gamma(\eta_c(2S)\gamma\gamma)\,B(\eta_c(2S)\rightarrow K\bar{K}\pi) = (0.18 \pm 0.05 \pm 0.02) \, \Gamma(\eta_c(1S)\gamma\gamma)\,B(\eta_c(1S)\rightarrow K\bar{K}\pi)$. The value for $\Gamma(\eta_c(2S)\rightarrow \gamma\gamma)$ is derived assuming that the branching fractions for $\eta_c(2S)$ and $\eta_c(1S)$ decays to $KS\bar{K}\pi$ are equal and using $\Gamma(\eta_c(1S)\rightarrow \gamma\gamma) = 7.4 \pm 0.4 \pm 2.3$ keV.

$$\eta_c(2S)\, \Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$$

<table>
<thead>
<tr>
<th>$\Gamma(2\pi^+2\pi^-)$</th>
<th>$\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALUE (eV)</td>
<td>CL%</td>
</tr>
<tr>
<td>$&lt;6.5$</td>
<td>90</td>
</tr>
</tbody>
</table>

$\Gamma(K\bar{K}\pi)$ | $\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ |

<table>
<thead>
<tr>
<th>VALUE (eV)</th>
<th>$\pm$</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$41 \pm 4 \pm 6$</td>
<td>624</td>
<td>17 DEL-AMO-SA..11m</td>
<td>BABR</td>
<td>$\gamma\gamma \rightarrow K^0_S K^{\pm\mp}$</td>
</tr>
</tbody>
</table>

$\Gamma(K^+K^-\pi^+\pi^-)$ | $\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ |

<table>
<thead>
<tr>
<th>VALUE (eV)</th>
<th>CL%</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt;5.0$</td>
<td>90</td>
<td>UEHARA</td>
<td>08</td>
<td>$\gamma\gamma \rightarrow \eta_c(2S) \rightarrow K^+K^-\pi^+\pi^-$</td>
</tr>
</tbody>
</table>

$\Gamma(K^+K^-\pi^+\pi^-\pi^0)$ | $\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ |

<table>
<thead>
<tr>
<th>VALUE (eV)</th>
<th>CL%</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$30 \pm 6 \pm 5$</td>
<td>1201</td>
<td>18 DEL-AMO-SA..11m</td>
<td>BABR</td>
<td>$\gamma\gamma \rightarrow K^+K^-\pi^+\pi^-\pi^0$</td>
</tr>
</tbody>
</table>

$\Gamma(2K^+2K^-)$ | $\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ |

<table>
<thead>
<tr>
<th>VALUE (eV)</th>
<th>CL%</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt;2.9$</td>
<td>90</td>
<td>UEHARA</td>
<td>08</td>
<td>$\gamma\gamma \rightarrow \eta_c(2S) \rightarrow 2(K^+K^-)$</td>
</tr>
</tbody>
</table>

$\Gamma(\pi^+\pi^-\eta_c(1S))$ | $\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ |

<table>
<thead>
<tr>
<th>VALUE (eV)</th>
<th>CL%</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt;133$</td>
<td>90</td>
<td>LEES</td>
<td>12AE</td>
<td>BABR</td>
</tr>
</tbody>
</table>

$$\eta_c(2S)\, \Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$$

$\Gamma(\rho\bar{\rho})/\Gamma_{\text{total}} \times \Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ | $\Gamma_{13}/\Gamma \times \Gamma_{14}/\Gamma$ |

<table>
<thead>
<tr>
<th>VALUE (units $10^{-8}$)</th>
<th>CL%</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt; 5.6$</td>
<td>90</td>
<td>19,20,21 AMBROGIANI</td>
<td>E835</td>
<td>$\rho\bar{\rho} \rightarrow \gamma\gamma$</td>
</tr>
<tr>
<td>$&lt; 8.0$</td>
<td>90</td>
<td>19,20,22 AMBROGIANI</td>
<td>E835</td>
<td>$\rho\bar{\rho} \rightarrow \gamma\gamma$</td>
</tr>
<tr>
<td>$&lt;12.0$</td>
<td>90</td>
<td>20,22 AMBROGIANI</td>
<td>E835</td>
<td>$\rho\bar{\rho} \rightarrow \gamma\gamma$</td>
</tr>
</tbody>
</table>

16 Including the measurements of of ARMSTRONG 95 in the AMBROGIANI 01 analysis.
17 For a total width $\Gamma$=5 MeV.
18 For the resonance mass region 3589–3599 MeV/c$^2$.
19 For the resonance mass region 3575–3660 MeV/c$^2$.
### $\eta_c(2S)$ Branching Ratios

#### $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>not seen</td>
<td>ABREU 980 DMLPH</td>
<td>e$^+e^- \rightarrow e^+e^- + \text{hadrons}$</td>
<td></td>
</tr>
</tbody>
</table>

- We do not use the following data for averages, fits, limits, etc.

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>seen</td>
<td>EDWARDS 82C CBAL</td>
<td>e$^+e^- \rightarrow \gamma X$</td>
<td></td>
</tr>
</tbody>
</table>

23 For a mass value of 3594 ± 5 MeV

#### $\Gamma(K\bar{K}\pi)/\Gamma_{\text{total}}$

<table>
<thead>
<tr>
<th>VALUE (units 10^{-2})</th>
<th>EVTS</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9±0.4±1.1</td>
<td>59 ± 12</td>
<td>AUBERT 08AB BABR</td>
<td>B → $\eta_c(2S)K \rightarrow K\bar{K}\pi K$</td>
<td></td>
</tr>
</tbody>
</table>

- We do not use the following data for averages, fits, limits, etc.

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>seen</td>
<td>ABLIKIM 13K BES3</td>
<td>$\psi(2S) \rightarrow \gamma K\bar{K}\pi$</td>
<td></td>
</tr>
<tr>
<td>seen</td>
<td>CHOI 02 BELL</td>
<td>$\psi(2S) \rightarrow \gamma K\bar{K}\pi$</td>
<td></td>
</tr>
</tbody>
</table>

24 Derived from a measurement of $[B(B^+ \rightarrow \eta_c(2S)K^+) \times B(\eta_c(2S) \rightarrow K\bar{K}\pi)] / [B(B^+ \rightarrow \eta_c K^+) \times B(\eta_c \rightarrow K\bar{K}\pi)] = (9.6^{+2.0}_{-1.9} \pm 2.5)\%$ and using $B(B^+ \rightarrow \eta_c(2S)K^+) = (3.4 \pm 1.8) \times 10^{-4}$, and $[B(B^+ \rightarrow \eta_c K^+) \times B(\eta_c \rightarrow K\bar{K}\pi)] = (6.88 \pm 0.77^{+0.55}_{-0.66}) \times 10^{-5}$.

25 For a mass value of 3654 ± 6 MeV

#### $\Gamma(2\pi^+2\pi^-)/\Gamma_{\text{total}}$

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>not seen</td>
<td>UEHARA 08 BELL</td>
<td>$\gamma \gamma \rightarrow \eta_c(2S)$</td>
<td></td>
</tr>
</tbody>
</table>

#### $\Gamma(\rho^0\rho^0)/\Gamma_{\text{total}}$

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>not seen</td>
<td>ABLIKIM 11H BES3</td>
<td>$\psi(2S) \rightarrow \gamma 2\pi^+2\pi^-$</td>
<td></td>
</tr>
</tbody>
</table>

#### $\Gamma(K^+K^-\pi^+\pi^-)/\Gamma_{\text{total}}$

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>not seen</td>
<td>UEHARA 08 BELL</td>
<td>$\gamma \gamma \rightarrow \eta_c(2S)$</td>
<td></td>
</tr>
</tbody>
</table>

#### $\Gamma(K^+K^-\pi^+\pi^-\pi^0)/\Gamma(K\bar{K}\pi)$

<table>
<thead>
<tr>
<th>VALUE</th>
<th>EVTS</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.73±0.17±0.17</td>
<td>1201</td>
<td>DEL-AMO-SA..11M BABR</td>
<td>$\gamma \gamma \rightarrow K^+K^-\pi^+\pi^-\pi^0$</td>
<td></td>
</tr>
</tbody>
</table>

26 We have multiplied the value of $\Gamma(K^+K^-\pi^+\pi^-\pi^0)/\Gamma(K\bar{K}\pi)$ reported in DEL-AMO-SANCHEZ 11M by a factor 1/3 to obtain $\Gamma(K^+K^-\pi^+\pi^-\pi^0)/\Gamma(K\bar{K}\pi)$. Not independent from other measurements reported in DEL-AMO-SANCHEZ 11M.

#### $\Gamma(K^{*0}\bar{K}^{*0})/\Gamma_{\text{total}}$

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>not seen</td>
<td>ABLIKIM 11H BES3</td>
<td>$\psi(2S) \rightarrow \gamma K^+K^-\pi^+\pi^-$</td>
<td></td>
</tr>
</tbody>
</table>

#### $\Gamma(K^{*0}_S K^{-2\pi^+\pi^-+\text{c.c.}})/\Gamma_{\text{total}}$

<table>
<thead>
<tr>
<th>VALUE</th>
<th>EVTS</th>
<th>DOCUMENT ID</th>
<th>TECN</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>seen</td>
<td>57 ± 17</td>
<td>ABLIKIM 13K BES3</td>
<td>$\psi(2S) \rightarrow \gamma K^{*0}_S K^{\pm\pi^+\pi^+\pi^-}$</td>
<td></td>
</tr>
</tbody>
</table>

Citation: K.A. Olive et al. (Particle Data Group), Chin. Phys. C38, 090001 (2014) (URL: http://pdg.lbl.gov)
\[ \frac{\Gamma(2K^+2K^-)}{\Gamma_{\text{total}}} \]

\[ \frac{\Gamma_{11}/\Gamma}{\text{not seen}} \]

\[ \frac{\Gamma(\phi\phi)/\Gamma_{\text{total}}}{\text{not seen}} \]

\[ \frac{\Gamma(\gamma\gamma)/\Gamma_{\text{total}}}{\Phi} \]

\begin{align*}
\text{VALUE} & \quad \text{CL}\% & \quad \text{DOCUMENT ID} & \quad \text{TECN} & \quad \text{COMMENT} \\
<5 \times 10^{-4} & \quad 90 & \quad \text{WICH} & \quad \text{BELL} & \quad \text{not seen} \\
<0.01 & \quad 90 & \quad \text{AMBROGIANI} & \quad \text{E835} & \quad \text{not seen} \\
\end{align*}

\[ \text{\(2^7\text{WICH} 08\) reports } [\Gamma(\eta_c(2S) \to \gamma\gamma)/\Gamma_{\text{total}}] \times [B(B^+ \to \eta_c(2S)K^+)] < 0.18 \times 10^{-6} \]

\[ \text{which we divide by our best value } B(B^+ \to \eta_c(2S)K^+) = 3.4 \times 10^{-4}. \]

\[ \frac{\Gamma(\pi^+\pi^- \eta_c(1S))/\Gamma(K\bar{K}\pi)}{\gamma_c(2S)} \]

\[ \text{\(2^8\text{LEES} 12\text{AE BABR} \)} \]

\[ \text{\(e^+e^- \to e^+e^-\pi^+\pi^- \eta_c\)} \]

\[ \text{\(2^8\text{We divided the reported limit by 3 to take into account isospin relations.}\)} \]

\[ \text{\(\eta_c(2S)\) CROSS-PARTICLE BRANCING RATIOS} \]

\[ \frac{\Gamma(\eta_c(2S) \to 2\pi^+2\pi^-)/\Gamma_{\text{total}}}{} \times \frac{\Gamma(\psi(2S) \to \gamma\eta_c(2S))/\Gamma_{\text{total}}}{\gamma_c(2S)} \]

\[ \frac{\Gamma_3/\Gamma \times \Gamma_{\psi(2S)}/\Gamma_{\psi(2S)}}{\text{\(2^9\text{CRONIN-HEN}.10\)} \quad \text{CLEO}} \]

\[ \text{\(\psi(2S) \to \gamma2\pi^+2\pi^-\)} \]

\[ \text{\(2^9\text{Assuming } \Gamma(\eta_c(2S)) = 14 \text{ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.}\)} \]

\[ \frac{\Gamma(\eta_c(2S) \to \rho^0\rho^0)/\Gamma_{\text{total}}}{} \times \frac{\Gamma(\psi(2S) \to \gamma\eta_c(2S))/\Gamma_{\text{total}}}{\gamma_c(2S)} \]

\[ \frac{\Gamma_4/\Gamma \times \Gamma_{\psi(2S)}/\Gamma_{\psi(2S)}}{\text{\(2^9\text{ABLIKIM} 11\text{H BES3} \)} \quad \text{BES3}} \]

\[ \text{\(\psi(2S) \to \gamma2\pi^+2\pi^-\)} \]

\[ \text{\(2^9\text{Assuming } \Gamma(\eta_c(2S)) = 14 \text{ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.}\)} \]

\[ \text{\(\eta_c(2S)\) CROSS-PARTICLE BRANCING RATIOS} \]

\[ \frac{\Gamma(\eta_c(2S) \to 3\pi^+3\pi^-)/\Gamma_{\text{total}}}{} \times \frac{\Gamma(\psi(2S) \to \gamma\eta_c(2S))/\Gamma_{\text{total}}}{\gamma_c(2S)} \]

\[ \frac{\Gamma_5/\Gamma \times \Gamma_{\psi(2S)}/\Gamma_{\psi(2S)}}{\text{\(2^9\text{CRONIN-HEN}.10\)} \quad \text{CLEO}} \]

\[ \text{\(\psi(2S) \to \gamma3\pi^+3\pi^-\)} \]

\[ \text{\(2^9\text{Assuming } \Gamma(\eta_c(2S)) = 14 \text{ MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.}\)} \]
\[ \Gamma(\eta_c(2S) \to K^+ K^- \pi^+ \pi^-) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \to \gamma \eta_c(2S)) / \Gamma_{\text{total}} \]

\[
\Gamma_6 / \Gamma \times \Gamma(\psi(2S) / \Gamma_{\psi(2S)}
\]

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<td>(&lt; 9.6 \times 10^{-6})</td>
<td>90</td>
<td>31 CRONIN-HEN..10</td>
<td>CLEO</td>
<td>\psi(2S) \to \gamma K^+ K^- \pi^+ \pi^-</td>
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31 Assuming \(\Gamma(\eta_c(2S)) = 14\) MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

\[ \Gamma(\eta_c(2S) \to K^0 K^{*0}) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \to \eta_c(2S)) / \Gamma_{\text{total}} \]

\[
\Gamma_7 / \Gamma \times \Gamma(\psi(2S) / \Gamma_{\psi(2S)}
\]

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<td>(&lt; 19.6 \times 10^{-7})</td>
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<td>\psi(2S) \to \gamma K^+ K^- \pi^+ \pi^-</td>
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32 Assuming \(\Gamma(\eta_c(2S)) = 14\) MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

\[ \Gamma(\eta_c(2S) \to K^- K^+ 2\pi^-) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \to \eta_c(2S)) / \Gamma_{\text{total}} \]

\[
\Gamma_9 / \Gamma \times \Gamma(\psi(2S) / \Gamma_{\psi(2S)}
\]

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<td>CLEO</td>
<td>\psi(2S) \to \gamma K^+ K^- 2\pi^-</td>
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</table>

33 Assuming \(\Gamma(\eta_c(2S)) = 14\) MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

\[ \Gamma(\eta_c(2S) \to K_S^0 K^- 2\pi^+ \pi^- + \text{c.c.}) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \to \eta_c(2S)) / \Gamma_{\text{total}} \]

\[
\Gamma_{10} / \Gamma \times \Gamma(\psi(2S) / \Gamma_{\psi(2S)}
\]

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<td>(7.03 \pm 2.10 \pm 0.7)</td>
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<td>13K BES3</td>
<td>\psi(2S) \to \gamma K_S^0 K^- 2\pi^+ \pi^- + \text{c.c.}</td>
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\(\bullet \bullet \bullet\) We do not use the following data for averages, fits, limits, etc. \(\bullet \bullet \bullet\)

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<td>(&lt; 15.2)</td>
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<td>CLEO</td>
<td>\psi(2S) \to \gamma K_S^0 K^- 2\pi^+ \pi^- + \text{c.c.}</td>
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34 Assuming \(\Gamma(\eta_c(2S)) = 14\) MeV. CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

\[ \Gamma(\eta_c(2S) \to \phi \phi) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \to \eta_c(2S)) / \Gamma_{\text{total}} \]

\[
\Gamma_{12} / \Gamma \times \Gamma(\psi(2S) / \Gamma_{\psi(2S)}
\]

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<td>(&lt; 7.8 \times 10^{-7})</td>
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<td>ABLIKIM</td>
<td>11H BES3</td>
<td>\psi(2S) \to \gamma K^+ K^- K^+ K^-</td>
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\[ \bullet \bullet \bullet\] For limits see the PDG table for \(\eta_c(2S)\) with \(\phi \phi\) final state.

\[ \bullet \bullet \bullet\] We do not use the following data for averages, fits, limits, etc. \(\bullet \bullet \bullet\)
\[ \Gamma(\eta_c(2S) \rightarrow \pi^+\pi^-) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}} \]

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<td>\psi(2S) \rightarrow \gamma \pi^+\pi^-</td>
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Assuming \( \Gamma(\eta_c(2S)) = 14 \text{ MeV} \). CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

\[ \Gamma(\eta_c(2S) \rightarrow \pi^+\pi^- \eta') / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}} \]

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<td>&lt;14.2 \times 10^{-6}</td>
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<td>\psi(2S) \rightarrow \gamma \pi^+\pi^- \eta'</td>
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Assuming \( \Gamma(\eta_c(2S)) = 14 \text{ MeV} \). CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

\[ \Gamma(\eta_c(2S) \rightarrow K^+K^-) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}} \]

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<td>&lt;5.9 \times 10^{-6}</td>
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<td>\psi(2S) \rightarrow \gamma K^+K^-</td>
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Assuming \( \Gamma(\eta_c(2S)) = 14 \text{ MeV} \). CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

\[ \Gamma(\eta_c(2S) \rightarrow \pi^+\pi^- \eta_c(1S)) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}} \]

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<td>\psi(2S) \rightarrow \gamma \pi^+\pi^- \eta_c(1S)</td>
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Assuming \( \Gamma(\eta_c(2S)) = 14 \text{ MeV} \). CRONIN-HENNESSY 10 gives the analytic dependence of limits on width.

\[ \Gamma(\eta_c(2S) \rightarrow p\bar{p}) / \Gamma_{\text{total}} \times \Gamma(\psi(2S) \rightarrow \gamma \eta_c(2S)) / \Gamma_{\text{total}} \]

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<td>&lt;1.4 \times 10^{-6}</td>
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<td>\psi(2S) \rightarrow \gamma p\bar{p}</td>
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