

**$Z_c(4430)$** 

$$I^G(J^{PC}) = 1^+(1^{+-})$$

$I, G, C$  need confirmation.

was  $X(4430)^\pm$ 

Properties incompatible with a  $q\bar{q}$  structure (exotic state). See the review on non- $q\bar{q}$  states.

First seen by CHOI 08 in  $B \rightarrow K\pi^+\psi(2S)$  decays, confirmed by AAIJ 14AG, and confirmed in a model-independent way by AAIJ 15BH. Also seen by CHILIKIN 14 in  $B \rightarrow K^+\pi J/\psi$  decays.  $J^P$  was determined by CHILIKIN 13 and AAIJ 14AG.

 **$Z_c(4430)$  MASS**

| <u>VALUE (MeV)</u>  | <u>DOCUMENT ID</u>    | <u>TECN</u> | <u>COMMENT</u>                     |
|---|-----------------------|-------------|------------------------------------|
| <b><math>4478^{+15}_{-18}</math> OUR AVERAGE</b>                              |                       |             |                                    |
| $4475 \pm 7^{+15}_{-25}$  | <sup>1</sup> AAIJ     | 14AG LHCB   | $B^0 \rightarrow K^+\pi^-\psi(2S)$ |
| $4485 \pm 22^{+28}_{-11}$   | <sup>1</sup> CHILIKIN | 13 BELL     | $B^0 \rightarrow K^+\pi^-\psi(2S)$ |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● |                       |             |                                    |
| $4443^{+15+19}_{-12-13}$  | <sup>2</sup> MIZUK    | 09 BELL     | $B \rightarrow K\pi^+\psi(2S)$     |
| $4433 \pm 4 \pm 2$  | <sup>3</sup> CHOI     | 08 BELL     | $B \rightarrow K\pi^+\psi(2S)$     |

<sup>1</sup> From a four-dimensional amplitude analysis.<sup>2</sup> From a Dalitz plot analysis. Superseded by CHILIKIN 13.<sup>3</sup> Superseded by MIZUK 09 and CHILIKIN 13. **$Z_c(4430)$  WIDTH**

| <u>VALUE (MeV)</u>  | <u>DOCUMENT ID</u>    | <u>TECN</u> | <u>COMMENT</u>                     |
|---|-----------------------|-------------|------------------------------------|
| <b><math>181 \pm 31</math> OUR AVERAGE</b>                                    |                       |             |                                    |
| $172 \pm 13^{+37}_{-34}$  | <sup>1</sup> AAIJ     | 14AG LHCB   | $B^0 \rightarrow K^+\pi^-\psi(2S)$ |
| $200^{+41+26}_{-46-35}$   | <sup>1</sup> CHILIKIN | 13 BELL     | $B^0 \rightarrow K^+\pi^-\psi(2S)$ |
| ● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ● |                       |             |                                    |
| $107^{+86+74}_{-43-56}$   | <sup>2</sup> MIZUK    | 09 BELL     | $B \rightarrow K\pi^+\psi(2S)$     |
| $45^{+18+30}_{-13-13}$  | <sup>3</sup> CHOI     | 08 BELL     | $B \rightarrow K\pi^+\psi(2S)$     |

<sup>1</sup> From a four-dimensional amplitude analysis.<sup>2</sup> From a Dalitz plot analysis. Superseded by CHILIKIN 13.<sup>3</sup> Superseded by MIZUK 09 and CHILIKIN 13.

**Z<sub>c</sub>(4430) DECAY MODES**

| Mode                        | Fraction ( $\Gamma_i/\Gamma$ ) |
|-----------------------------|--------------------------------|
| $\Gamma_1$ $\pi^+ \psi(2S)$ | seen                           |
| $\Gamma_2$ $\pi^+ J/\psi$   | seen                           |

**Z<sub>c</sub>(4430) BRANCHING RATIOS**

$\Gamma(\pi^+ \psi(2S))/\Gamma_{\text{total}}$   $\Gamma_1/\Gamma$

| VALUE   | DOCUMENT ID | TECN      | COMMENT                              |
|---|-------------|-----------|--------------------------------------|
| <b>seen</b>   | 1 AAIJ      | 14AG LHCB | $B^0 \rightarrow K^+ \pi^- \psi(2S)$ |
| <b>seen</b>   | 2 CHILIKIN  | 13 BELL   | $B^0 \rightarrow K^+ \pi^- \psi(2S)$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |             |           |                                      |
| not seen  | 3 AUBERT    | 09AA BABR | $B \rightarrow K \pi^+ \psi(2S)$     |
| seen  | 4 MIZUK     | 09 BELL   | $B \rightarrow K \pi^+ \psi(2S)$     |

<sup>1</sup> From a four-dimensional amplitude analysis. No product of branching fractions quoted.

<sup>2</sup> From a four-dimensional amplitude analysis. Measured a product of branching fractions  $B(B^0 \rightarrow Z_c(4430)^- K^+) \times B(Z_c(4430)^- \rightarrow \psi(2S) \pi^-) = (6.0^{+1.7+2.5}_{-2.0-1.4}) \times 10^{-5}$ .

<sup>3</sup> AUBERT 09AA quotes  $B(B^+ \rightarrow \bar{K}^0 Z_c(4430)^+) \times B(Z_c(4430)^+ \rightarrow \pi^+ \psi(2S)) < 4.7 \times 10^{-5}$  and  $B(\bar{B}^0 \rightarrow K^- Z_c(4430)^+) \times B(Z_c(4430)^+ \rightarrow \pi^+ \psi(2S)) < 3.1 \times 10^{-5}$  at 95% CL.

<sup>4</sup> Measured a product of branching fractions  $B(\bar{B}^0 \rightarrow K^- Z_c(4430)^+) \times B(Z_c(4430)^+ \rightarrow \pi^+ \psi(2S)) = (3.2^{+1.8+5.3}_{-0.9-1.6}) \times 10^{-5}$ . Superseded by CHILIKIN 13.

$\Gamma(\pi^+ J/\psi)/\Gamma_{\text{total}}$   $\Gamma_2/\Gamma$

| VALUE   | DOCUMENT ID | TECN      | COMMENT                                  |
|---|-------------|-----------|--|
| <b>seen</b>   | 1 CHILIKIN  | 14 BELL   | $\bar{B}^0 \rightarrow K^- \pi^+ J/\psi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • |             |           |  |
| not seen  | 2 AUBERT    | 09AA BABR | $B \rightarrow K \pi^+ J/\psi$           |

<sup>1</sup> CHILIKIN 14 reports  $B(\bar{B}^0 \rightarrow Z_c(4430)^+ K^-) \times B(Z_c(4430)^+ \rightarrow J/\psi \pi^+) = (5.4^{+4.0+1.1}_{-1.0-0.9}) \times 10^{-6}$ .

<sup>2</sup> AUBERT 09AA quotes  $B(B^+ \rightarrow \bar{K}^0 Z_c(4430)^+) \times B(Z_c(4430)^+ \rightarrow \pi^+ J/\psi) < 1.5 \times 10^{-5}$  and  $B(\bar{B}^0 \rightarrow K^- Z_c(4430)^+) \times B(Z_c(4430)^+ \rightarrow \pi^+ J/\psi) < 0.4 \times 10^{-5}$  at 95% CL.

**Z<sub>c</sub>(4430) REFERENCES**

|          |                     |                           |                    |
|----------|---------------------|---------------------------|--------------------|
| AAIJ     | 15BH PR D92 112009  | R. Aaij <i>et al.</i>     | (LHCb Collab.)     |
| AAIJ     | 14AG PRL 112 222002 | R. Aaij <i>et al.</i>     | (LHCb Collab.) JP  |
| CHILIKIN | 14 PR D90 112009    | K. Chilikin <i>et al.</i> | (BELLE Collab.)    |
| CHILIKIN | 13 PR D88 074026    | K. Chilikin <i>et al.</i> | (BELLE Collab.) JP |
| AUBERT   | 09AA PR D79 112001  | B. Aubert <i>et al.</i>   | (BABAR Collab.)    |
| MIZUK    | 09 PR D80 031104    | R. Mizuk <i>et al.</i>    | (BELLE Collab.)    |
| CHOI     | 08 PRL 100 142001   | S.-K. Choi <i>et al.</i>  | (BELLE Collab.)    |