

$T_{c\bar{c}1}(4430)^+$

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

G, C need confirmation.

was $Z_c(4430)$, $X(4430)^\pm$

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.

 $T_{c\bar{c}1}(4430)^+$ MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
4478^{+15}_{-17} OUR AVERAGE			
$4468 \pm 21 \pm 80$	AAIJ	25Q LHCb	$B^+ \rightarrow \psi(2S)K^+\pi^+\pi^-$
$4475 \pm 7^{+15}_{-25}$	¹ AAIJ	14AG LHCb	$\bar{B}^0 \rightarrow K^-\pi^+\psi(2S)$
$4485 \pm 22^{+28}_{-11}$	¹ 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}	² MIZUK	09 BELL	$B \rightarrow K\pi^+\psi(2S)$
$4433 \pm 4 \pm 2$	³ CHOI	08 BELL	$B \rightarrow K\pi^+\psi(2S)$

¹ From a four-dimensional amplitude analysis.² From a Dalitz plot analysis. Superseded by CHILIKIN 13.³ Superseded by MIZUK 09 and CHILIKIN 13. $T_{c\bar{c}1}(4430)^+$ WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
189 ± 29 OUR AVERAGE			
$251 \pm 42 \pm 82$	AAIJ	25Q LHCb	$B^+ \rightarrow \psi(2S)K^+\pi^+\pi^-$
$172 \pm 13^{+37}_{-34}$	¹ AAIJ	14AG LHCb	$\bar{B}^0 \rightarrow K^-\pi^+\psi(2S)$
200^{+41+26}_{-46-35}	¹ 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}	² MIZUK	09 BELL	$B \rightarrow K\pi^+\psi(2S)$
45^{+18+30}_{-13-13}	³ CHOI	08 BELL	$B \rightarrow K\pi^+\psi(2S)$

¹ From a four-dimensional amplitude analysis.² From a Dalitz plot analysis. Superseded by CHILIKIN 13.³ Superseded by MIZUK 09 and CHILIKIN 13.

$T_{c\bar{c}1}(4430)^+$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $\pi^+ \psi(2S)$	seen
Γ_2 $\pi^+ J/\psi$	seen

 $T_{c\bar{c}1}(4430)^+$ BRANCHING RATIOS $\Gamma(\pi^+ \psi(2S))/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
seen	AAIJ	25Q LHCb	$B^+ \rightarrow \psi(2S) K^+ \pi^+ \pi^-$
seen	¹ AAIJ	14AG LHCb	$\bar{B}^0 \rightarrow K^- \pi^+ \psi(2S)$
seen	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	$B \rightarrow K \pi^+ \psi(2S)$

¹ From a four-dimensional amplitude analysis. No product of branching fractions quoted.

² From a four-dimensional amplitude analysis. Measured a product of branching fractions $B(B^0 \rightarrow T_{c\bar{c}1}(4430)^- K^+) \times B(T_{c\bar{c}1}(4430)^- \rightarrow \psi(2S) \pi^-) = (6.0^{+1.7+2.5}_{-2.0-1.4}) \times 10^{-5}$.

³ AUBERT 09AA quotes $B(B^+ \rightarrow \bar{K}^0 T_{c\bar{c}1}(4430)^+) \times B(T_{c\bar{c}1}(4430)^+ \rightarrow \pi^+ \psi(2S)) < 4.7 \times 10^{-5}$ and $B(\bar{B}^0 \rightarrow K^- T_{c\bar{c}1}(4430)^+) \times B(T_{c\bar{c}1}(4430)^+ \rightarrow \pi^+ \psi(2S)) < 3.1 \times 10^{-5}$ at 95% CL.

⁴ Measured a product of branching fractions $B(\bar{B}^0 \rightarrow K^- T_{c\bar{c}1}(4430)^+) \times B(T_{c\bar{c}1}(4430)^+ \rightarrow \pi^+ \psi(2S)) = (3.2^{+1.8+5.3}_{-0.9-1.6}) \times 10^{-5}$. Superseded by CHILIKIN 13.

 $\Gamma(\pi^+ J/\psi)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
seen	^{1,2} 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	³ AUBERT	09AA BABR	$B \rightarrow K \pi^+ J/\psi$

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

² A broad enhancement seen by AAIJ 19R in the decays $B^0 \rightarrow J/\psi \pi^+ K^-$ at 4600 MeV can be due to an interplay of $T_{c\bar{c}1}(4430)$, $T_{c\bar{c}1}(4200)$ and the fitting polynomials.

³ AUBERT 09AA quotes $B(B^+ \rightarrow \bar{K}^0 T_{c\bar{c}1}(4430)^+) \times B(T_{c\bar{c}1}(4430)^+ \rightarrow \pi^+ J/\psi) < 1.5 \times 10^{-5}$ and $B(\bar{B}^0 \rightarrow K^- T_{c\bar{c}1}(4430)^+) \times B(T_{c\bar{c}1}(4430)^+ \rightarrow \pi^+ J/\psi) < 0.4 \times 10^{-5}$ at 95% CL.

$T_{c\bar{c}1}(4430)^+$ REFERENCES

AAIJ	25Q	JHEP 2501 054	R. Aaij <i>et al.</i>	(LHCb Collab.)
AAIJ	19R	PRL 122 152002	R. Aaij <i>et al.</i>	(LHCb Collab.)
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.)
