$\chi_{b2}(2P)$

$I^G(J^{PC}) = 0^+(2^{++})$
J needs confirmation.

Observed in radiative decay of the $\Upsilon(3S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$.

$\chi_{b2}(2P)$ MASS

VALUE (MeV)	DOCUMENT ID
10268.65±0.22±0.50 OUR EVALUATION	From γ energy below, using $\Upsilon(3S)$ mass = 10355.2 ± 0.5 MeV

$m_{\chi_{b2}(2P)} - m_{\chi_{b1}(2P)}$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
13.10±0.24 OUR AVERAGE				
12.3 ±2.6 ±0.6	[1] AAIJ	14BG	LHCB	$p p \to \gamma \mu^+ \mu^- X$
13.04±0.26	LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
13.5 ±0.4 ±0.5	[2] HEINTZ	92	CSB2	$e^+ e^- \to \gamma X, \ell^+\ell^-\gamma\gamma$

[1] From the $\chi_{bj}(2P) \to \Upsilon(1S)\gamma$ transition.

[2] From the average photon energy for inclusive and exclusive events. Supersedes NARAIN 91.

γ ENERGY IN $\Upsilon(3S)$ DECAY

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
86.19±0.22 OUR EVALUATION		Treating systematic errors as correlated			
86.40±0.18 OUR AVERAGE					
86.04±0.06±0.27		ARTUSO	05	CLEO	$\Upsilon(3S) \to \gamma X$
86 ±1	101	CRAWFORD	92B	CLE2	$e^+ e^- \to \ell^+\ell^-\gamma\gamma$
86.7 ±0.4	10319	[3] HEINTZ	92	CSB2	$e^+ e^- \to \gamma X$
86.9 ±0.4	157	[4] HEINTZ	92	CSB2	$e^+ e^- \to \ell^+\ell^-\gamma\gamma$
86.4 ±0.1 ±0.4	30741	MORRISON	91	CLE2	$e^+ e^- \to \gamma X$

[3] A systematic uncertainty on the energy scale of 0.9% not included. Supersedes NARAIN 91.

[4] A systematic uncertainty on the energy scale of 0.9% not included. Supersedes HEINTZ 91.

$\chi_{b2}(2P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	$\omega\Upsilon(1S)$	$(1.10^{+0.34}_{-0.30})$ %	
Γ_2	$\gamma\Upsilon(2S)$	(8.9 ± 1.2) %	
Γ_3	$\gamma\Upsilon(1S)$	(6.6 ± 0.8) %	
Γ_4	$\pi\pi\chi_{b2}(1P)$	$(5.1 \pm 0.9) \times 10^{-3}$	
Γ_5	$D^0 X$	< 2.4 %	90%
Γ_6	$\pi^+\pi^- K^+ K^- \pi^0$	$< 1.1 \times 10^{-4}$	90%

Γ_7	$2\pi^+\pi^- K^- K^0_S$	$< 9 \times 10^{-5}$	90%
Γ_8	$2\pi^+\pi^- K^- K^0_S 2\pi^0$	$< 7 \times 10^{-4}$	90%
Γ_9	$2\pi^+ 2\pi^- 2\pi^0$	$(3.9 \pm 1.6) \times 10^{-4}$	
Γ_{10}	$2\pi^+ 2\pi^- K^+ K^-$	$(9 \pm 4) \times 10^{-5}$	
Γ_{11}	$2\pi^+ 2\pi^- K^+ K^- \pi^0$	$(2.4 \pm 1.1) \times 10^{-4}$	
Γ_{12}	$2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	$(4.7 \pm 2.3) \times 10^{-4}$	
Γ_{13}	$3\pi^+ 2\pi^- K^- K^0_S \pi^0$	$< 4 \times 10^{-4}$	90%
Γ_{14}	$3\pi^+ 3\pi^-$	$(9 \pm 4) \times 10^{-5}$	
Γ_{15}	$3\pi^+ 3\pi^- 2\pi^0$	$(1.2 \pm 0.4) \times 10^{-3}$	
Γ_{16}	$3\pi^+ 3\pi^- K^+ K^-$	$(1.4 \pm 0.7) \times 10^{-4}$	
Γ_{17}	$3\pi^+ 3\pi^- K^+ K^- \pi^0$	$(4.2 \pm 1.7) \times 10^{-4}$	
Γ_{18}	$4\pi^+ 4\pi^-$	$(9 \pm 5) \times 10^{-5}$	
Γ_{19}	$4\pi^+ 4\pi^- 2\pi^0$	$(1.3 \pm 0.5) \times 10^{-3}$	

$\chi_{b2}(2P)$ BRANCHING RATIOS

$\Gamma(\omega \Upsilon(1S))/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
$1.10^{+0.32}_{-0.28}{}^{+0.11}_{-0.10}$	$20.1^{+5.8}_{-5.1}$	[5] CRONIN-HEN..04	CLE3	$\Upsilon(3S) \to \gamma\omega\Upsilon(1S)$

[5] Using B($\Upsilon(3S) \to \gamma\chi_{b2}(2P)$) = (11.4 ± 0.8)% and B($\Upsilon(1S) \to \ell^+\ell^-$) = 2 B($\Upsilon(1S) \to \mu^+\mu^-$) = 2 (2.48 ± 0.06)%.

$\Gamma(\gamma \Upsilon(2S))/\Gamma_{\text{total}}$ — Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.089±0.012 OUR AVERAGE					
0.085±0.010±0.010		[6,7,8] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
0.084±0.011±0.010	2.5k	[9] LEES	11J	BABR	$\Upsilon(3S) \to X\gamma$
0.096±0.022±0.012		[7,10] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
0.106±0.016±0.013		[7,11] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

[6] LEES 14M quotes $\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(2S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b2}(2P))/\Gamma_{\text{total}}$ = (1.12 ± 0.13)% combining the results from samples of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with and without converted photons.

[7] Assuming B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.93 ± 0.17)%.

[8] LEES 14M reports [$\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(2S))/\Gamma_{\text{total}}$] × [B($\Upsilon(3S) \to \gamma\chi_{b2}(2P)$)] = (1.12 ± 0.13) × 10^{-2} which we divide by our best value B($\Upsilon(3S) \to \gamma\chi_{b2}(2P)$) = (13.1 ± 1.6) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[9] LEES 11J reports [$\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(2S))/\Gamma_{\text{total}}$] × [B($\Upsilon(3S) \to \gamma\chi_{b2}(2P)$)] = (1.1 ± 0.1 ± 0.1) × 10^{-2} which we divide by our best value B($\Upsilon(3S) \to \gamma\chi_{b2}(2P)$) = (13.1 ± 1.6) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[10] CRAWFORD 92B quotes B($\Upsilon(3S) \to \gamma\chi_{b1}(2P)$) ×B($\chi_{b2}(2P) \to \gamma\Upsilon(2S)$) × 2 B($\Upsilon(2S) \to \ell^+\ell^-$) = (4.98 ± 0.94 ± 0.62) 10^{-4}.

[11] Recalculated by us. HEINTZ 92 quotes B($\Upsilon(3S) \to \gamma\chi_{b2}(2P)$) ×B($\chi_{b2}(2P) \to \gamma\Upsilon(2S)$) = (1.90 ± 0.23 ± 0.18) % using B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.44 ± 0.10)%. Supersedes HEINTZ 91.

$\Gamma(\gamma \Upsilon(1S))/\Gamma_{total}$ Γ_3/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.066±0.008 OUR AVERAGE				
0.061±0.004±0.007		[12,13,14] LEES 14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
0.070±0.004±0.008	11k	[15] LEES 11J	BABR	$\Upsilon(3S) \to X\gamma$
0.077±0.018±0.009		[13,16] CRAWFORD 92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
0.061±0.009±0.007		[13,17] HEINTZ 92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

[12] LEES 14M quotes $\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(1S))/\Gamma_{total} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b2}(2P))/\Gamma_{total} = (8.03 \pm 0.50) \times 10^{-3}$ combining the results from samples of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with and without converted photons.

[13] Assuming $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.48 \pm 0.05)\%$.

[14] LEES 14M reports $[\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (8.03 \pm 0.50) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[15] LEES 11J reports $[\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (9.2 \pm 0.3 \pm 0.4) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[16] CRAWFORD 92B quotes $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\chi_{b2}(2P) \to \gamma\Upsilon(1S)) \times 2\, B(\Upsilon(1S) \to \ell^+\ell^-) = (5.03 \pm 0.94 \pm 0.63)\ 10^{-4}$.

[17] Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\chi_{b2}(2P) \to \gamma\Upsilon(1S)) =(0.77 \pm 0.11 \pm 0.05)\%$ using $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.57 \pm 0.05)\%$. Supersedes HEINTZ 91.

$\Gamma(\pi\pi\chi_{b2}(1P))/\Gamma_{total}$ Γ_4/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT
5.1±0.9 OUR AVERAGE				
4.9±0.7±0.6	17k	[18] LEES 11C	BABR	$e^+e^- \to \pi^+\pi^- X$
6.0±1.6±1.4		[19] CAWLFIELD 06	CLE3	$\Upsilon(3S) \to 2(\gamma\pi\ell)$

[18] $(0.64 \pm 0.05 \pm 0.08) \times 10^{-3}$. We derive the value assuming $B(\Upsilon(3S) \to \chi_{b2}(2P)X) = B(\Upsilon(3S) \to \chi_{b2}(2P)\gamma) = (13.1 \pm 1.6) \times 10^{-2}$.

[19] CAWLFIELD 06 quote $\Gamma(\chi_b(2P) \to \pi\pi\chi_b(1P)) = 0.83 \pm 0.22 \pm 0.08 \pm 0.19$ keV assuming I-spin conservation, no D-wave contribution, $\Gamma(\chi_{b1}(2P)) = 96 \pm 16$keV, and $\Gamma(\chi_{b2}(2P)) = 138 \pm 19$ keV.

$\Gamma(D^0 X)/\Gamma_{total}$ Γ_5/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<2.4 × 10⁻²	90	[20,21] BRIERE 08	CLEO	$\Upsilon(3S) \to \gamma D^0 X$

[20] For $p_{D^0} > 2.5$ GeV/c.

[21] The authors also present their result as $(0.2 \pm 1.4 \pm 0.1) \times 10^{-2}$.

$\Gamma(\pi^+\pi^- K^+ K^- \pi^0)/\Gamma_{total}$ Γ_6/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<1.1	90	[22] ASNER 08A	CLEO	$\Upsilon(3S) \to \gamma\pi^+\pi^- K^+ K^- \pi^0$

[22] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to \pi^+\pi^- K^+ K^- \pi^0)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] < 14 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = 13.1 \times 10^{-2}$.

$\Gamma(2\pi^+\pi^- K^- K^0_S)/\Gamma_{total}$ Γ_7/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<0.9	90	[23] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 2\pi^+\pi^- K^- K^0_S$

[23] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 2\pi^+\pi^- K^- K^0_S)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] < 12 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = 13.1 \times 10^{-2}$.

$\Gamma(2\pi^+\pi^- K^- K^0_S 2\pi^0)/\Gamma_{total}$ Γ_8/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<7	90	[24] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 2\pi^+\pi^- K^- 2\pi^0$

[24] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 2\pi^+\pi^- K^- K^0_S 2\pi^0)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] < 87 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = 13.1 \times 10^{-2}$.

$\Gamma(2\pi^+ 2\pi^- 2\pi^0)/\Gamma_{total}$ Γ_9/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
3.9±1.6±0.5	23	[25] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 2\pi^+ 2\pi^- 2\pi^0$

[25] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 2\pi^+ 2\pi^- 2\pi^0)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (51 \pm 16 \pm 13) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(2\pi^+ 2\pi^- K^+ K^-)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.9±0.4±0.1	11	[26] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 2\pi^+ 2\pi^- K^+ K^-$

[26] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 2\pi^+ 2\pi^- K^+ K^-)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (12 \pm 4 \pm 3) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(2\pi^+ 2\pi^- K^+ K^- \pi^0)/\Gamma_{total}$ Γ_{11}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.4±1.0±0.3	16	[27] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 2\pi^+ 2\pi^- K^+ K^- \pi^0$

[27] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 2\pi^+ 2\pi^- K^+ K^- \pi^0)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (32 \pm 11 \pm 8) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(2\pi^+ 2\pi^- K^+ K^- 2\pi^0)/\Gamma_{total}$ Γ_{12}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
4.7±2.2±0.6	14	[28] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 2\pi^+ 2\pi^- K^+ K^- 2\pi^0$

[28] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 2\pi^+ 2\pi^- K^+ K^- 2\pi^0)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (62 \pm 23 \pm 17) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(3\pi^+2\pi^-K^-K^0_S\pi^0)/\Gamma_{total}$ Γ_{13}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<4	90	[29] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 3\pi^+2\pi^-K^-K^0_S\pi^0$

[29] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 3\pi^+2\pi^-K^-K^0_S\pi^0)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] < 58 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = 13.1 \times 10^{-2}$.

$\Gamma(3\pi^+3\pi^-)/\Gamma_{total}$ Γ_{14}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.9±0.4±0.1	14	[30] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 3\pi^+3\pi^-$

[30] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 3\pi^+3\pi^-)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (12 \pm 4 \pm 3) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(3\pi^+3\pi^-2\pi^0)/\Gamma_{total}$ Γ_{15}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
12±4±1	45	[31] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 3\pi^+3\pi^-2\pi^0$

[31] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 3\pi^+3\pi^-2\pi^0)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (159 \pm 33 \pm 43) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(3\pi^+3\pi^-K^+K^-)/\Gamma_{total}$ Γ_{16}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.4±0.7±0.2	12	[32] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 3\pi^+3\pi^-K^+K^-$

[32] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 3\pi^+3\pi^-K^+K^-)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (19 \pm 7 \pm 5) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(3\pi^+3\pi^-K^+K^-\pi^0)/\Gamma_{total}$ Γ_{17}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
4.2±1.7±0.5	16	[33] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 3\pi^+3\pi^-K^+K^-\pi^0$

[33] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 3\pi^+3\pi^-K^+K^-\pi^0)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (55 \pm 16 \pm 15) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(4\pi^+4\pi^-)/\Gamma_{total}$ Γ_{18}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.9±0.4±0.1	9	[34] ASNER	08A	CLEO	$\Upsilon(3S) \to \gamma 4\pi^+4\pi^-$

[34] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \to 4\pi^+4\pi^-)/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (12 \pm 5 \pm 3) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(4\pi^+ 4\pi^- 2\pi^0)/\Gamma_{\text{total}}$ Γ_{19}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
13±5±2	27	[35] ASNER	08A	CLEO	$\Upsilon(3S) \rightarrow \gamma 4\pi^+ 4\pi^- 2\pi^0$

[35] ASNER 08A reports $[\Gamma(\chi_{b2}(2P) \rightarrow 4\pi^+ 4\pi^- 2\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma \chi_{b2}(2P))] = (165 \pm 46 \pm 50) \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma \chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\chi_{b2}(2P)$ Cross-Particle Branching Ratios

$\Gamma(\chi_{b2}(2P) \rightarrow \gamma \Upsilon(1S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma \chi_{b2}(2P))/\Gamma_{\text{total}}$ $\Gamma_3/\Gamma \times \Gamma_{20}^{\Upsilon(3S)}/\Gamma^{\Upsilon(3S)}$

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
9.2±0.3±0.4	11k	LEES	11J	BABR	$\Upsilon(3S) \rightarrow X\gamma$

$\Gamma(\chi_{b2}(2P) \rightarrow \gamma \Upsilon(2S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma \chi_{b2}(2P))/\Gamma_{\text{total}}$ $\Gamma_2/\Gamma \times \Gamma_{20}^{\Upsilon(3S)}/\Gamma^{\Upsilon(3S)}$

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
1.1±0.1±0.1	2.5k	LEES	11J	BABR	$\Upsilon(3S) \rightarrow X\gamma$

$B(\chi_{b2}(2P) \rightarrow \chi_{b2}(1P)\pi^+\pi^-) \times B(\Upsilon(3S) \rightarrow \chi_{b2}(2P)X)$

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.64±0.05±0.08	17k	LEES	11C	BABR	$e^+e^- \rightarrow \pi^+\pi^- X$

$B(\chi_{b2}(2P) \rightarrow \gamma \Upsilon(1S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b2}(2P)) \times B(\Upsilon(1S) \rightarrow \ell^+\ell^-)$

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.02±0.18 OUR AVERAGE					
$1.95^{+0.22}_{-0.21}{}^{+0.10}_{-0.16}$		[36] LEES	14M	BABR	$\Upsilon(3S) \rightarrow \gamma\gamma\mu^+\mu^-$
2.52±0.47±0.32	48	[37] CRAWFORD	92B	CLE2	$\Upsilon(3S) \rightarrow \gamma\gamma\ell^+\ell^-$
1.98±0.28±0.12		[38] HEINTZ	92	CSB2	$\Upsilon(3S) \rightarrow \gamma\gamma\ell^+\ell^-$

[36] From a sample of $\Upsilon(3S) \rightarrow \gamma\gamma\mu^+\mu^-$ with converted photons.

[37] CRAWFORD 92B quotes $2\times B(\Upsilon(3S) \rightarrow \gamma\chi_{bJ}(2P))$ $B(\chi_{bJ}(2P) \rightarrow \gamma\Upsilon(\text{nS}))$ $B(\Upsilon(\text{nS}) \rightarrow \ell^+\ell^-)$.

[38] Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \rightarrow \gamma\chi_{b2}(2P))\times B(\chi_{b2}(2P) \rightarrow \gamma\Upsilon(1S)) =(0.77 \pm 0.11 \pm 0.05)\%$ using$B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.57 \pm 0.05)\%$.

$[B(\chi_{b2}(2P) \rightarrow \gamma \Upsilon(1S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b2}(2P))]$ / $[B(\chi_{b1}(2P) \rightarrow \gamma \Upsilon(1S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b1}(2P))]$

VALUE (%)	DOCUMENT ID		TECN	COMMENT
66.6±3.0	[39] LEES	14M	BABR	$\Upsilon(3S) \rightarrow \gamma\gamma\mu^+\mu^-$

[39] From a sample of $\Upsilon(3S) \rightarrow \gamma\gamma\mu^+\mu^-$ events without converted photons.

$B(\chi_{b2}(2P) \rightarrow \gamma \Upsilon(2S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b2}(2P)) \times B(\Upsilon(2S) \rightarrow \ell^+\ell^-)$

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.74±0.29 OUR AVERAGE					
$3.22^{+0.58}_{-0.53}{}^{+0.16}_{-0.71}$		[40] LEES	14M	BABR	$\Upsilon(3S) \rightarrow \gamma\gamma\mu^+\mu^-$

2.49±0.47±0.31	53	[41] CRAWFORD	92B	CLE2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$
2.74±0.33±0.18		[42] HEINTZ	92	CSB2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$

[40] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with converted photons.

[41] CRAWFORD 92B quotes 2×B($\Upsilon(3S) \to \gamma\chi_{bJ}(2P)$) B($\chi_{bJ}(2P) \to \gamma\Upsilon$(nS)) B($\Upsilon$(nS) $\to \ell^+\ell^-$).

[42] Calculated by us. HEINTZ 92 quotes B($\Upsilon(3S) \to \gamma\chi_{b2}(2P)$) ×B($\chi_{b2}(2P) \to \gamma\Upsilon(2S)$) = (1.90 ± 0.23 ± 0.18) % using B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.44 ± 0.10)%.

[B($\chi_{b2}(2P) \to \gamma\Upsilon(2S)$) × B($\Upsilon(3S) \to \gamma\chi_{b2}(2P)$)] / [B($\chi_{b1}(2P) \to \gamma\Upsilon(2S)$) × B($\Upsilon(3S) \to \gamma\chi_{b1}(2P)$)]

VALUE (%)	*DOCUMENT ID*		*TECN*	*COMMENT*
46.9±2.0	[43] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$

[43] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ without converted photons.

$\chi_{b2}(2P)$ REFERENCES

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