Λ_b^0

$I(J^P) = 0(\frac{1}{2}^+)$ Status: ∗∗∗

In the quark model, a Λ_b^0 is an isospin-0 $u\,d\,b$ state. The lowest Λ_b^0 ought to have $J^P = 1/2^+$. None of I, J, or P have actually been measured.

Λ_b^0 MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
5620.2± 1.6 OUR AVERAGE					
5619.7± 1.2± 1.2		[1] ACOSTA	06	CDF	$p\overline{p}$ at 1.96 TeV
5621 ± 4 ± 3		[2] ABE	97B	CDF	$p\overline{p}$ at 1.8 TeV
5668 ± 16 ± 8	4	[3] ABREU	96N	DLPH	$e^+e^- \to Z$
5614 ± 21 ± 4	4	[3] BUSKULIC	96L	ALEP	$e^+e^- \to Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
not seen		[4] ABE	93B	CDF	Sup. by ABE 97B
5640 ± 50 ±30	16	[5] ALBAJAR	91E	UA1	$p\overline{p}$ 630 GeV
5640 $^{+100}_{-210}$	52	BARI	91	SFM	$\Lambda_b^0 \to pD^0\pi^-$
5650 $^{+150}_{-200}$	90	BARI	91	SFM	$\Lambda_b^0 \to \Lambda_c^+\pi^+\pi^-\pi^-$

[1] Uses exclusively reconstructed final states containing a $J/\psi \to \mu^+\mu^-$ decays.

[2] ABE 97B observed 38 events with a background of 18 ± 1.6 events in the mass range 5.60–5.65 GeV/c^2, a significance of > 3.4 standard deviations.

[3] Uses 4 fully reconstructed Λ_b events.

[4] ABE 93B states that, based on the signal claimed by ALBAJAR 91E, CDF should have found 30 ± 23 $\Lambda_b^0 \to J/\psi(1S)\Lambda$ events. Instead, CDF found not more than 2 events.

[5] ALBAJAR 91E claims 16 ± 5 events above a background of 9 ± 1 events, a significance of about 5 standard deviations.

$m_{\Lambda_b} - m_{B^0}$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
339.2±1.4±0.1	[6] ACOSTA	06	CDF	$p\overline{p}$ at 1.96 TeV

[6] Uses exclusively reconstructed final states containing a $J/\psi \to \mu^+\mu^-$ decays.

Λ_b^0 MEAN LIFE

See b-baryon Admixture section for data on b-baryon mean life average over species of b-baryon particles.

"OUR EVALUATION" is an average using rescaled values of the data listed below. The average and rescaling were performed by the Heavy Flavor Averaging Group (HFAG) and are described at http://www.slac.stanford.edu/xorg/hfag/. The averaging/rescaling procedure takes into account correlations between the measurements and asymmetric lifetime errors.

VALUE (10^{-12} s)	EVTS	DOCUMENT ID	TECN	COMMENT
$1.383^{+0.049}_{-0.048}$ OUR EVALUATION				
$1.218^{+0.130}_{-0.115}\pm0.042$		[7] ABAZOV 07S	D0	$p\overline{p}$ at 1.96 TeV
$1.290^{+0.119}_{-0.110}{}^{+0.087}_{-0.091}$		[8] ABAZOV 07U	D0	$p\overline{p}$ at 1.96 TeV
$1.593^{+0.083}_{-0.078}\pm0.033$		[7] ABULENCIA 07A	CDF	$p\overline{p}$ at 1.96 TeV
$1.11\ ^{+0.19}_{-0.18}\pm0.05$		[9] ABREU 99W	DLPH	$e^+e^- \rightarrow Z$
$1.29\ ^{+0.24}_{-0.22}\pm0.06$		[9] ACKERSTAFF 98G	OPAL	$e^+e^- \rightarrow Z$
$1.21\ \pm0.11$		[9] BARATE 98D	ALEP	$e^+e^- \rightarrow Z$
$1.32\ \pm0.15\ \pm0.07$		[10] ABE 96M	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$1.22\ ^{+0.22}_{-0.18}\pm0.04$		[7] ABAZOV 05C	D0	Repl. by ABAZOV 07S
$1.19\ ^{+0.21}_{-0.18}{}^{+0.07}_{-0.08}$		ABREU 96D	DLPH	Repl. by ABREU 99W
$1.14\ ^{+0.22}_{-0.19}\pm0.07$	69	AKERS 95K	OPAL	Repl. by ACKERSTAFF 98G
$1.02\ ^{+0.23}_{-0.18}\pm0.06$	44	BUSKULIC 95L	ALEP	Repl. by BARATE 98D

[7] Measured mean life using fully reconstructed $\Lambda_b^0 \rightarrow J/\psi\Lambda$ decays.

[8] Measured using semileptonic decays $\Lambda_b^0 \rightarrow \Lambda_c^+\mu\nu X$ and $\Lambda_c^+ \rightarrow K_S^0 p$.

[9] Measured using $\Lambda_c\ell^-$ and $\Lambda\ell^+\ell^-$.

[10] Excess $\Lambda_c\ell^-$, decay lengths.

$\tau_{\Lambda_b^0}/\tau_{B^0}$ MEAN LIFE RATIO

$\tau_{\Lambda_b^0}/\tau_{B^0}$ (direct measurements)

VALUE	DOCUMENT ID	TECN	COMMENT
0.99 ±0.10 OUR AVERAGE	Error includes scale factor of 2.0.		
$0.811^{+0.096}_{-0.087}\pm0.034$	[11,12] ABAZOV 07S	D0	$p\overline{p}$ at 1.96 TeV
1.041 ± 0.057	[13] ABULENCIA 07A	CDF	$p\overline{p}$ at 1.96 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$0.87\ ^{+0.17}_{-0.14}\pm0.03$	[13] ABAZOV 05C	D0	Repl. by ABAZOV 07S

[11] Uses fully reconstructed $\Lambda_b \rightarrow J/\psi\Lambda$ decays.

[12] Uses $B^0 \rightarrow J/\psi K_S^0$ decays for denominator.

[13] Measured mean life ratio using fully reconstructed decays.

Λ_b^0 DECAY MODES

These branching fractions are actually an average over weakly decaying b-baryons weighted by their production rates in Z decay (or high-energy $p\overline{p}$), branching ratios, and detection efficiencies. They scale with the LEP b-baryon production fraction B($b \rightarrow$ b-baryon) and are evaluated for our value B($b \rightarrow$ b-baryon) = (9.2 ± 1.8)%.

The branching fractions B(b-baryon $\rightarrow$ $\Lambda \ell^- \overline{\nu}_\ell$ anything) and B($\Lambda_b^0 \rightarrow$ $\Lambda_c^+ \ell^- \overline{\nu}_\ell$ anything) are not pure measurements because the underlying measured products of these with B($b \rightarrow$ b-baryon) were used to determine B($b \rightarrow$ b-baryon), as described in the note "Production and Decay of b-Flavored Hadrons."

For inclusive branching fractions, *e.g.*, $B \rightarrow$ $D^\pm$ anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

	Mode		Fraction (Γ_i/Γ)	Confidence level
Γ_1	$J/\psi(1S)\Lambda$		$(4.7\pm2.8) \times 10^{-4}$	
Γ_2	$p D^0 \pi^-$			
Γ_3	$\Lambda_c^+ \pi^-$		$(8.8\pm3.2) \times 10^{-3}$	
Γ_4	$\Lambda_c^+ a_1(1260)^-$		seen	
Γ_5	$\Lambda_c^+ \pi^+ \pi^- \pi^-$			
Γ_6	$\Lambda K^0 2\pi^+ 2\pi^-$			
Γ_7	$\Lambda_c^+ \ell^- \overline{\nu}_\ell$ anything	[a]	(9.9 ± 2.6) %	
Γ_8	$\Lambda_c^+ \ell^- \overline{\nu}_\ell$		$(5.0^{+1.9}_{-1.4})$ %	
Γ_9	$\Lambda_c^+ \pi^+ \pi^- \ell^- \overline{\nu}_\ell$		(5.6 ± 3.1) %	
Γ_{10}	$p h^-$	[b]	$< 2.3 \times 10^{-5}$	90%
Γ_{11}	$p \pi^-$		$< 5.0 \times 10^{-5}$	90%
Γ_{12}	$p K^-$		$< 5.0 \times 10^{-5}$	90%
Γ_{13}	$\Lambda \gamma$		$< 1.3 \times 10^{-3}$	90%

[a] Not a pure measurement. See note at head of Λ_b^0 Decay Modes.

[b] Here h^- means π^- or K^-.

Λ_b^0 BRANCHING RATIOS

$\Gamma(J/\psi(1S)\Lambda)/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
4.7± 2.1± 1.9		[14] ABE	97B	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
196 ±120 ±40	16	[15] ALBAJAR	91E	UA1	$J/\psi(1S) \rightarrow \mu^+\mu^-$

[14] ABE 97B reports (0.037 ± 0.017(stat)±0.007(sys))% for B($b \to$ b-baryon) = 0.1 and for B($B^0 \to J/\psi(1S) K^0_S$) = 0.037%. We rescale to our PDG 98 best value B($b \to$ b-baryon) = $(10.1^{+3.9}_{-3.1})$% and B($B^0 \to J/\psi(1S) K^0_S$) = (0.044 ± 0.006)%. Our first error is their experiments's error and our second error is the systematic error from using our best value.

[15] ALBAJAR 91E reports (180 ± 110) × 10^{-4} for B($\overline{b} \to$ b-baryon) = 0.10. We rescale to our best value B($\overline{b} \to$ b-baryon) = (9.2 ± 1.9) × 10^{-2}. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(p D^0 \pi^-)/\Gamma_{total}$ — Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	52	BARI	91	SFM	$D^0 \to K^- \pi^+$
seen		BASILE	81	SFM	$D^0 \to K^- \pi^+$

$\Gamma(\Lambda_c^+ \pi^-)/\Gamma_{total}$ — Γ_3/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
8.8±2.8±1.5		[16] ABULENCIA	07B	CDF	$p\overline{p}$ at 1.96 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	3	ABREU	96N	DLPH	$\Lambda_c^+ \to p K^- \pi^+$
seen	4	BUSKULIC	96L	ALEP	$\Lambda_c^+ \to p K^- \pi^+$, $p \overline{K}^0$, $\Lambda \pi^+ \pi^+ \pi^-$

[16] The result is obtained from (f_{baryon}/f_d) (B($\Lambda_b^0 \to \Lambda_c^+ \pi^-$)/B($\overline{B}^0 \to D^+ \pi^-$)) = 0.82 ± 0.08 ± 0.11 ± 0.22, assuming f_{baryon}/f_d = 0.25 ± 0.04 and B($\overline{B}^0 \to D^+ \pi^-$) = (2.68 ± 0.13) × 10^{-3}.

$\Gamma(\Lambda_c^+ a_1(1260)^-)/\Gamma_{total}$ — Γ_4/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	1	ABREU	96N	DLPH	$\Lambda_c^+ \to p K^- \pi^+$, $a_1^- \to \rho^0 \pi^- \to \pi^+ \pi^- \pi^-$

$\Gamma(\Lambda_c^+ \pi^+ \pi^- \pi^-)/\Gamma_{total}$ — Γ_5/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	90	BARI	91	SFM	$\Lambda_c^+ \to p K^- \pi^+$

$\Gamma(\Lambda K^0 2\pi^+ 2\pi^-)/\Gamma_{total}$ — Γ_6/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	4	[17] ARENTON	86	FMPS	$\Lambda K^0_S 2\pi^+ 2\pi^-$

[17] See the footnote to the ARENTON 86 mass value.

$\Gamma(\Lambda_c^+ \ell^- \overline{\nu}_\ell \text{anything})/\Gamma_{\text{total}}$ — Γ_7/Γ

The values and averages in this section serve only to show what values result if one assumes our B($b \rightarrow$ b-baryon). They cannot be thought of as measurements since the underlying product branching fractions were also used to determine B($b \rightarrow$ b-baryon) as described in the note on "Production and Decay of b-Flavored Hadrons."

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.099±0.026 OUR AVERAGE					
0.093±0.017±0.019		[18] BARATE	98D	ALEP	$e^+ e^- \rightarrow Z$
0.13 ±0.04 ±0.03	29	[19] ABREU	95S	DLPH	$e^+ e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.082±0.020±0.017	55	[20] BUSKULIC	95L	ALEP	Repl. by BARATE 98D
0.16 ±0.06 ±0.03	21	[21] BUSKULIC	92E	ALEP	$\Lambda_c^+ \rightarrow p K^- \pi^+$

[18] BARATE 98D reports [B($\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \overline{\nu}_\ell$ anything)] × [B($\overline{b} \rightarrow$ b-baryon)] = 0.0086 ± 0.0007 ± 0.0014. We divide by our best value B($\overline{b} \rightarrow$ b-baryon) = $(9.2 \pm 1.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Measured using $\Lambda_c \ell^-$ and $\Lambda \ell^+ \ell^-$.

[19] ABREU 95S reports [B($\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \overline{\nu}_\ell$ anything)] × [B($\overline{b} \rightarrow$ b-baryon)] = $0.0118 \pm 0.0026^{+0.0031}_{-0.0021}$. We divide by our best value B($\overline{b} \rightarrow$ b-baryon) = $(9.2 \pm 1.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[20] BUSKULIC 95L reports [B($\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \overline{\nu}_\ell$ anything)] × [B($\overline{b} \rightarrow$ b-baryon)] = 0.00755 ± 0.0014 ± 0.0012. We divide by our best value B($\overline{b} \rightarrow$ b-baryon) = $(9.2 \pm 1.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[21] BUSKULIC 92E reports [B($\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \overline{\nu}_\ell$ anything)] × [B($\overline{b} \rightarrow$ b-baryon)] = 0.015 ± 0.0035 ± 0.0045. We divide by our best value B($\overline{b} \rightarrow$ b-baryon) = $(9.2 \pm 1.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Superseded by BUSKULIC 95L.

$\Gamma(\Lambda_c^+ \ell^- \overline{\nu}_\ell)/\Gamma_{\text{total}}$ — Γ_8/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.050^{+0.011}_{-0.008}{}^{+0.016}_{-0.012}}$	[22] ABDALLAH	04A	DLPH	$e^+ e^- \rightarrow Z^0$

[22] Derived from a combined likelihood and event rate fit to the distribution of the Isgur-Wise variable and using HQET. The slope of the form factor is measured to be $\rho^2 = 2.03 \pm 0.46^{+0.72}_{-1.00}$.

$\Gamma(\Lambda_c^+ \pi^+ \pi^- \ell^- \overline{\nu}_\ell)/\Gamma_{\text{total}}$ — Γ_9/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.056^{+0.031}_{-0.030}}$	[23] ABDALLAH	04A	DLPH	$e^+ e^- \rightarrow Z^0$

[23] Derived from the fraction of $\Gamma(\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \overline{\nu}_\ell)$ / ($\Gamma(\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \overline{\nu}_\ell)$ + $\Gamma(\Lambda_b^0 \rightarrow \Lambda_c^+ \pi^+ \pi^- \ell^- \overline{\nu}_\ell)$) = $0.47^{+0.10}_{-0.08}{}^{+0.07}_{-0.06}$.

$\Gamma(\Lambda_c^+ \ell^- \overline{\nu}_\ell)/[\Gamma(\Lambda_c^+ \ell^- \overline{\nu}_\ell) + \Gamma(\Lambda_c^+ \pi^+ \pi^- \ell^- \overline{\nu}_\ell)]$ — $\Gamma_8/(\Gamma_8+\Gamma_9)$

VALUE	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.47^{+0.10}_{-0.08}{}^{+0.07}_{-0.06}}$	ABDALLAH	04A	DLPH	$e^+ e^- \rightarrow Z^0$

$\Gamma(ph^-)/\Gamma_{\text{total}}$ Γ_{10}/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<2.3 \times 10^{-5}$	90	[24] ACOSTA	05O	CDF	$p\overline{p}$ at 1.96 TeV

[24] Assumes f_{Λ} / $f_d = 0.25$, and equal momentum distribution for Λ_b and B mesons.

$\Gamma(p\pi^-)/\Gamma_{\text{total}}$ Γ_{11}/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<5.0 \times 10^{-5}$	90	[25] BUSKULIC	96V	ALEP	$e^+e^- \to Z$

[25] BUSKULIC 96V assumes PDG 96 production fractions for B^0, B^+, B_s, b baryons.

$\Gamma(pK^-)/\Gamma_{\text{total}}$ Γ_{12}/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<5.0 \times 10^{-5}$	90	[26] BUSKULIC	96V	ALEP	$e^+e^- \to Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<3.6 \times 10^{-4}$	90	[27] ADAM	96D	DLPH	$e^+e^- \to Z$

[26] BUSKULIC 96V assumes PDG 96 production fractions for B^0, B^+, B_s, b baryons.
[27] ADAM 96D assumes $f_{B^0} = f_{B^-} = 0.39$ and $f_{B_s} = 0.12$.

$\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$ Γ_{13}/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<1.3 \times 10^{-3}$	90	ACOSTA	02G	CDF	$p\overline{p}$ at 1.8 TeV

Λ_b^0 REFERENCES

ABAZOV	07S	PRL 99 142001	V.M. Abazov *et al.*	(D0 Collab.)
ABAZOV	07U	PRL 99 182001	V.M. Abazov *et al.*	(D0 Collab.)
ABULENCIA	07A	PRL 98 122001	A. Abulencia *et al.*	(FNAL CDF Collab.)
ABULENCIA	07B	PRL 98 122002	A. Abulencia *et al.*	(FNAL CDF Collab.)
ACOSTA	06	PRL 96 202001	D. Acosta *et al.*	(CDF Collab.)
ABAZOV	05C	PRL 94 102001	V.M. Abazov *et al.*	(D0 Collab.)
ACOSTA	05O	PR D72 051104R	D. Acosta *et al.*	(CDF Collab.)
ABDALLAH	04A	PL B585 63	J. Abdallah *et al.*	(DELPHI Collab.)
ACOSTA	02G	PR D66 112002	D. Acosta *et al.*	(CDF Collab.)
ABREU	99W	EPJ C10 185	P. Abreu *et al.*	(DELPHI Collab.)
ACKERSTAFF	98G	PL B426 161	K. Ackerstaff *et al.*	(OPAL Collab.)
BARATE	98D	EPJ C2 197	R. Barate *et al.*	(ALEPH Collab.)
PDG	98	EPJ C3 1	C. Caso *et al.*	
ABE	97B	PR D55 1142	F. Abe *et al.*	(CDF Collab.)
ABE	96M	PRL 77 1439	F. Abe *et al.*	(CDF Collab.)
ABREU	96D	ZPHY C71 199	P. Abreu *et al.*	(DELPHI Collab.)
ABREU	96N	PL B374 351	P. Abreu *et al.*	(DELPHI Collab.)
ADAM	96D	ZPHY C72 207	W. Adam *et al.*	(DELPHI Collab.)
BUSKULIC	96L	PL B380 442	D. Buskulic *et al.*	(ALEPH Collab.)
BUSKULIC	96V	PL B384 471	D. Buskulic *et al.*	(ALEPH Collab.)
PDG	96	PR D54 1	R. M. Barnett *et al.*	
ABREU	95S	ZPHY C68 375	P. Abreu *et al.*	(DELPHI Collab.)
AKERS	95K	PL B353 402	R. Akers *et al.*	(OPAL Collab.)
BUSKULIC	95L	PL B357 685	D. Buskulic *et al.*	(ALEPH Collab.)
ABE	93B	PR D47 R2639	F. Abe *et al.*	(CDF Collab.)
BUSKULIC	92E	PL B294 145	D. Buskulic *et al.*	(ALEPH Collab.)
ALBAJAR	91E	PL B273 540	C. Albajar *et al.*	(UA1 Collab.)
BARI	91	NC 104A 1787	G. Bari *et al.*	(CERN R422 Collab.)
ARENTON	86	NP B274 707	M.W. Arenton *et al.*	(ARIZ, NDAM, VAND)
BASILE	81	LNC 31 97	M. Basile *et al.*	(CERN R415 Collab.)