



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

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

### $\Lambda_b^0$ MASS

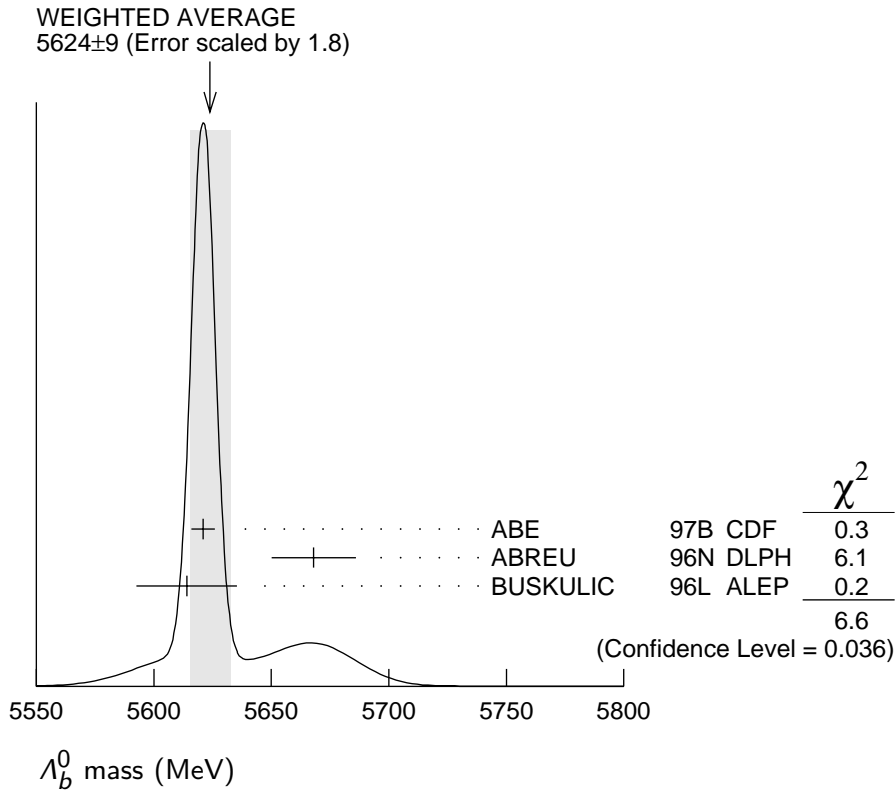
VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
<b>5624 ± 9</b>	<b>OUR AVERAGE</b>	Error includes scale factor of 1.8. See the ideogram below.		
5621 ± 4 ± 3		<sup>1</sup> ABE	97B CDF	$p\bar{p}$ at 1.8 TeV
5668 ± 16 ± 8	4	<sup>2</sup> ABREU	96N DLPH	$e^+e^- \rightarrow Z$
5614 ± 21 ± 4	4	<sup>2</sup> BUSKULIC	96L ALEP	$e^+e^- \rightarrow Z$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
not seen		<sup>3</sup> ABE	93B CDF	Sup. by ABE 97B
5640 ± 50 ± 30	16	<sup>4</sup> ALBAJAR	91E UA1	$p\bar{p}$ 630 GeV
5640 <sup>+100</sup> <sub>-210</sub>	52	BARI	91 SFM	$\Lambda_b^0 \rightarrow \rho D^0 \pi^-$
5650 <sup>+150</sup> <sub>-200</sub>	90	BARI	91 SFM	$\Lambda_b^0 \rightarrow \Lambda_c^+ \pi^+ \pi^- \pi^-$

<sup>1</sup> ABE 97B observed 38 events above a background  $18 \pm 1.6$  events in the mass range 5.60–5.65 GeV/ $c^2$ , a significance of  $> 3.4$  standard deviations.

<sup>2</sup> Uses 4 fully reconstructed  $\Lambda_b$  events.

<sup>3</sup> ABE 93B states that, based on the signal claimed by ALBAJAR 91E, CDF should have found  $30 \pm 23 \Lambda_b^0 \rightarrow J/\psi(1S)\Lambda$  events. Instead, CDF found not more than 2 events.

<sup>4</sup> ALBAJAR 91E claims  $16 \pm 5$  events above a background of  $9 \pm 1$  events, a significance of about 5 standard deviations.



## $\Lambda_b^0$ MEAN LIFE

These are actually measurements of the average lifetime of weakly decaying  $b$  baryons weighted by generally unknown production rates, branching fractions, and detection efficiencies. Presumably, the mix is mainly  $\Lambda_b^0$ , with some  $\Xi_b^0$  and  $\Xi_b^-$ .

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 corrections between the measurements and asymmetric lifetime errors.

<u>VALUE (<math>10^{-12}</math> s)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>1.229 \pm 0.080</math></b>				<b>OUR EVALUATION</b>
1.11 $^{+0.19}_{-0.18}$ $\pm 0.05$	5	ABREU	99W DLPH	$e^+ e^- \rightarrow Z$
1.29 $^{+0.24}_{-0.22}$ $\pm 0.06$	5	ACKERSTAFF	98G OPAL	$e^+ e^- \rightarrow Z$
1.21 $\pm 0.11$	5	BARATE	98D ALEP	$e^+ e^- \rightarrow Z$
1.32 $\pm 0.15$ $\pm 0.07$		ABE	96M CDF	Excess $\Lambda_c \ell^-$ , decay lengths

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

1.19	$\begin{matrix} +0.21 & +0.07 \\ -0.18 & -0.08 \end{matrix}$		ABREU	96D DLPH	Repl. by ABREU 99W
1.14	$\begin{matrix} +0.22 \\ -0.19 \end{matrix} \pm 0.07$	69	AKERS	95K OPAL	Repl. by ACKER-STAFF 98G
1.02	$\begin{matrix} +0.23 \\ -0.18 \end{matrix} \pm 0.06$	44	BUSKULIC	95L ALEP	Repl. by BARATE 98D

<sup>5</sup> Measured using  $\Lambda_c \ell^-$  and  $\Lambda \ell^+ \ell^-$ .

## $\Lambda_b^0$ 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  $p\bar{p}$ ), branching ratios, and detection efficiencies. They scale with the LEP  $b$ -baryon production fraction  $B(b \rightarrow b\text{-baryon})$  and are evaluated for our value  $B(b \rightarrow b\text{-baryon}) = (9.9 \pm 1.7)\%$ .

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

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

Mode	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level
$\Gamma_1$ $J/\psi(1S)\Lambda$	$(4.7 \pm 2.8) \times 10^{-4}$	
$\Gamma_2$ $pD^0\pi^-$		
$\Gamma_3$ $\Lambda_c^+\pi^-$	seen	
$\Gamma_4$ $\Lambda_c^+a_1(1260)^-$	seen	
$\Gamma_5$ $\Lambda_c^+\pi^+\pi^-\pi^-$		
$\Gamma_6$ $\Lambda K^0 2\pi^+ 2\pi^-$		
$\Gamma_7$ $\Lambda_c^+ \ell^- \bar{\nu}_\ell \text{ anything}$	[a] $(9.2 \pm 2.1)\%$	
$\Gamma_8$ $p\pi^-$	$< 5.0 \times 10^{-5}$	90%
$\Gamma_9$ $pK^-$	$< 5.0 \times 10^{-5}$	90%
$\Gamma_{10}$ $\Lambda\gamma$	$< 1.3 \times 10^{-3}$	90%

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

## $\Lambda_b^0$ BRANCHING RATIOS

$\Gamma(J/\psi(1S)\Lambda)/\Gamma_{\text{total}}$	$\Gamma_1/\Gamma$
VALUE (units $10^{-4}$ )	
$4.7 \pm 2.1 \pm 1.9$	
<i>EVTS</i>	<i>DOCUMENT ID</i>
6 ABE	97B CDF
<i>COMMENT</i>	$p\bar{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •	
182. $\pm 111. \pm 31.$	7 ALBAJAR
16	91E UA1
	$J/\psi(1S) \rightarrow \mu^+ \mu^-$

<sup>6</sup> ABE 97B reports  $(0.037 \pm 0.017(\text{stat}) \pm 0.007(\text{sys}))\%$  for  $B(b \rightarrow b\text{-baryon}) = 0.1$  and for  $B(B^0 \rightarrow J/\psi(1S)K_S^0) = 0.037\%$ . We rescale to our PDG 98 best value  $B(b \rightarrow b\text{-baryon}) = (10.1^{+3.9}_{-3.1})\%$  and  $B(B^0 \rightarrow J/\psi(1S)K_S^0) = (0.044 \pm 0.006)\%$ . Our first error is their experiments's error and our second error is the systematic error from using our best value.

<sup>7</sup> ALBAJAR 91E reports  $180 \pm 110$  for  $B(\bar{b} \rightarrow b\text{-baryon}) = 0.10$ . We rescale to our best value  $B(\bar{b} \rightarrow b\text{-baryon}) = (9.9 \pm 1.7) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

### $\Gamma(pD^0\pi^-)/\Gamma_{\text{total}}$ $\Gamma_2/\Gamma$

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

### $\Gamma(\Lambda_c^+ \pi^-)/\Gamma_{\text{total}}$ $\Gamma_3/\Gamma$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
seen	3	ABREU	96N DLPH	$\Lambda_c^+ \rightarrow pK^- \pi^+$
seen	4	BUSKULIC	96L ALEP	$\Lambda_c^+ \rightarrow pK^- \pi^+, \rho\bar{K}^0,$ $\Lambda\pi^+ \pi^+ \pi^-$

### $\Gamma(\Lambda_c^+ a_1(1260)^-)/\Gamma_{\text{total}}$ $\Gamma_4/\Gamma$

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

### $\Gamma(\Lambda_c^+ \pi^+ \pi^- \pi^-)/\Gamma_{\text{total}}$ $\Gamma_5/\Gamma$

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

### $\Gamma(\Lambda K^0 2\pi^+ 2\pi^-)/\Gamma_{\text{total}}$ $\Gamma_6/\Gamma$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
seen	4	<sup>8</sup> ARENTON	86 FMPS	$\Lambda K_S^0 2\pi^+ 2\pi^-$

<sup>8</sup> See the footnote to the ARENTON 86 mass value.

### $\Gamma(\Lambda_c^+ \ell^- \bar{\nu}_\ell \text{ anything})/\Gamma_{\text{total}}$ $\Gamma_7/\Gamma$

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

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
<b>0.092 ± 0.021 OUR AVERAGE</b>				
$0.087 \pm 0.016 \pm 0.015$		<sup>9</sup> BARATE	98D ALEP	$e^+ e^- \rightarrow Z$
$0.119^{+0.041}_{-0.034} \pm 0.020$	29	<sup>10</sup> ABREU	95S DLPH	$e^+ e^- \rightarrow Z$

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

0.076 ± 0.019 ± 0.013      55      11 BUSKULIC      95L ALEP      Repl. by BARATE 98D  
 0.15 ± 0.06 ± 0.03      21      12 BUSKULIC      92E ALEP       $\Lambda_c^+ \rightarrow \rho K^- \pi^+$

<sup>9</sup> BARATE 98D reports  $[B(\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \bar{\nu}_\ell \text{ anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.0086 \pm 0.0007 \pm 0.0014$ . We divide by our best value  $B(\bar{b} \rightarrow b\text{-baryon}) = (9.9 \pm 1.7) \times 10^{-2}$ . 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  $\Lambda \ell^+ \ell^-$ .

<sup>10</sup> ABREU 95S reports  $[B(\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \bar{\nu}_\ell \text{ anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.0118 \pm 0.0026^{+0.0031}_{-0.0021}$ . We divide by our best value  $B(\bar{b} \rightarrow b\text{-baryon}) = (9.9 \pm 1.7) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

<sup>11</sup> BUSKULIC 95L reports  $[B(\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \bar{\nu}_\ell \text{ anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.00755 \pm 0.0014 \pm 0.0012$ . We divide by our best value  $B(\bar{b} \rightarrow b\text{-baryon}) = (9.9 \pm 1.7) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

<sup>12</sup> BUSKULIC 92E reports  $[B(\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \bar{\nu}_\ell \text{ anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.015 \pm 0.0035 \pm 0.0045$ . We divide by our best value  $B(\bar{b} \rightarrow b\text{-baryon}) = (9.9 \pm 1.7) \times 10^{-2}$ . 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.

**$\Gamma(\rho\pi^-)/\Gamma_{\text{total}}$   $\Gamma_8/\Gamma$**

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b>&lt;5.0 × 10<sup>-5</sup></b>	90	<sup>13</sup> BUSKULIC	96V ALEP	$e^+ e^- \rightarrow Z$

<sup>13</sup> BUSKULIC 96V assumes PDG 96 production fractions for  $B^0$ ,  $B^+$ ,  $B_s$ ,  $b$  baryons.

**$\Gamma(\rho K^-)/\Gamma_{\text{total}}$   $\Gamma_9/\Gamma$**

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b>&lt;5.0 × 10<sup>-5</sup></b>	90	<sup>14</sup> BUSKULIC	96V ALEP	$e^+ e^- \rightarrow Z$

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

<3.6 × 10 <sup>-4</sup>	90	<sup>15</sup> ADAM	96D DLPH	$e^+ e^- \rightarrow Z$
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<sup>14</sup> BUSKULIC 96V assumes PDG 96 production fractions for  $B^0$ ,  $B^+$ ,  $B_s$ ,  $b$  baryons.

<sup>15</sup> ADAM 96D assumes  $f_{B^0} = f_{B^-} = 0.39$  and  $f_{B_s} = 0.12$ .

**$\Gamma(\Lambda\gamma)/\Gamma_{\text{total}}$   $\Gamma_{10}/\Gamma$**

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b>&lt;1.3 × 10<sup>-3</sup></b>	90	ACOSTA	02G CDF	$p\bar{p}$ at 1.8 TeV

**$\Lambda_b^0$  REFERENCES**

ACOSTA	02G	PR D66 112002	D. Acosta <i>et al.</i>	(CDF Collab.)
ABREU	99W	EPJ C10 185	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ACKERSTAFF	98G	PL B426 161	K. Ackerstaff <i>et al.</i>	(OPAL Collab.)
BARATE	98D	EPJ C2 197	R. Barate <i>et al.</i>	(ALEPH Collab.)
PDG	98	EPJ C3 1	C. Caso <i>et al.</i>	
ABE	97B	PR D55 1142	F. Abe <i>et al.</i>	(CDF Collab.)
ABE	96M	PRL 77 1439	F. Abe <i>et al.</i>	(CDF Collab.)
ABREU	96D	ZPHY C71 199	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	96N	PL B374 351	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ADAM	96D	ZPHY C72 207	W. Adam <i>et al.</i>	(DELPHI Collab.)
BUSKULIC	96L	PL B380 442	D. Buskulic <i>et al.</i>	(ALEPH Collab.)

BUSKULIC	96V	PL B384 471	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
PDG	96	PR D54 1	R. M. Barnett <i>et al.</i>	
ABREU	95S	ZPHY C68 375	P. Abreu <i>et al.</i>	(DELPHI Collab.)
AKERS	95K	PL B353 402	R. Akers <i>et al.</i>	(OPAL Collab.)
BUSKULIC	95L	PL B357 685	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
ABE	93B	PR D47 R2639	F. Abe <i>et al.</i>	(CDF Collab.)
BUSKULIC	92E	PL B294 145	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
ALBAJAR	91E	PL B273 540	C. Albajar <i>et al.</i>	(UA1 Collab.)
BARI	91	NC 104A 1787	G. Bari <i>et al.</i>	(CERN R422 Collab.)
ARENTON	86	NP B274 707	M.W. Arenton <i>et al.</i>	(ARIZ, NDAM, VAND)
BASILE	81	LNC 31 97	M. Basile <i>et al.</i>	(CERN R415 Collab.)

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