b

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

Charge $= -\frac{1}{3}\ e$ Bottom $= -1$

b-QUARK MASS

The first value is the "running mass" $\overline{m}_b(\mu = \overline{m}_b)$ in the $\overline{\text{MS}}$ scheme, and the second value is the $1S$ mass, which is half the mass of the $\Upsilon(1S)$ in perturbation theory. For a review of different quark mass definitions and their properties, see EL-KHADRA 02. The $1S$ mass is better suited for use in analyzing B decays than the $\overline{\text{MS}}$ mass because it gives a stable perturbative expansion. We have converted masses in other schemes to the $\overline{\text{MS}}$ mass and $1S$ mass using two-loop QCD perturbation theory with $\alpha_s(\mu = \overline{m}_b) = 0.22$. The values $4.20^{+0.17}_{-0.07}$ GeV for the $\overline{\text{MS}}$ mass and $4.68^{+0.17}_{-0.07}$ GeV for the $1S$ mass correspond to $4.79^{+0.19}_{-0.08}$ GeV for the pole mass, using the two-loop conversion formula. A discussion of masses in different schemes can be found in the "Note on Quark Masses."

$\overline{\text{MS}}$ *MASS* (GeV)	*1S MASS* (GeV)	*DOCUMENT ID*		*TECN*
$4.19^{+0.18}_{-0.06}$ **OUR EVALUATION** of $\overline{\text{MS}}$ Mass. See the ideogram below.				
$4.67^{+0.18}_{-0.06}$ **OUR EVALUATION** of $1S$ Mass. See the ideogram below.				
4.163 ± 0.016	4.640 ± 0.018	[1] CHETYRKIN	09	THEO
5.26 ± 1.2	5.86 ± 1.3	[2] ABDALLAH	08D	DLPH
$4.42 \pm 0.06 \pm 0.08$	$4.98 \pm 0.07 \pm 0.09$	[3] GUAZZINI	08	LATT
4.237 ± 0.049	4.723 ± 0.055	[4] SCHWANDA	08	BELL
$4.347 \pm 0.048 \pm 0.08$	$4.838 \pm 0.053 \pm 0.09$	[5] DELLA-MOR...	07	LATT
4.164 ± 0.025	4.635 ± 0.028	[6] KUHN	07	THEO
4.19 ± 0.40	4.66 ± 0.45	[7] ABDALLAH	06D	DLPH
4.205 ± 0.058	4.68 ± 0.06	[8] BOUGHEZAL	06	THEO
4.20 ± 0.04	4.67 ± 0.04	[9] BUCHMULLER	06	THEO
4.19 ± 0.06	4.66 ± 0.07	[10] PINEDA	06	THEO
4.4 ± 0.3	4.9 ± 0.3	[11,12] GRAY	05	LATT
4.22 ± 0.06	4.72 ± 0.07	[13] AUBERT	04X	THEO
4.17 ± 0.03	4.68 ± 0.03	[14] BAUER	04	THEO
4.22 ± 0.11	4.72 ± 0.12	[12,15] HOANG	04	THEO
4.25 ± 0.11	4.76 ± 0.12	[12,16] MCNEILE	04	LATT
4.22 ± 0.09	4.74 ± 0.10	[17] BAUER	03	THEO
4.19 ± 0.05	4.66 ± 0.05	[18] BORDES	03	THEO
4.20 ± 0.09	4.67 ± 0.10	[19] CORCELLA	03	THEO
4.33 ± 0.10	4.84 ± 0.11	[12,20] DEDIVITIIS	03	LATT
4.24 ± 0.10	4.72 ± 0.11	[21] EIDEMULLER	03	THEO
4.207 ± 0.031	4.682 ± 0.035	[22] ERLER	03	THEO
$4.33 \pm 0.06 \pm 0.10$	$4.82 \pm 0.07 \pm 0.11$	[23] MAHMOOD	03	THEO
4.190 ± 0.032	4.663 ± 0.036	[24] BRAMBILLA	02	THEO
4.346 ± 0.070	4.837 ± 0.078	[25] PENIN	02	THEO
4.05 ± 0.06	4.51 ± 0.07	[26] NARISON	01B	THEO
$4.210 \pm 0.090 \pm 0.025$	$4.69 \pm 0.100 \pm 0.028$	[27] PINEDA	01	THEO

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

3.95 ± 0.57	4.40 ± 0.63	[28] ABBIENDI	01S	OPAL
4.203 ± 0.026	4.678 ± 0.029	[29] BRAMBILLA	01	THEO
4.21 ± 0.05	4.69 ± 0.06	[30] KUHN	01	THEO
4.7 ± 0.74	5.23 ± 0.82	[31] BARATE	00V	ALEP
4.20 ± 0.06	4.71 ± 0.03	[32] HOANG	00	THEO
$4.437^{+0.045}_{-0.029}$	$4.938^{+0.050}_{-0.032}$	[33] LUCHA	00	THEO
$4.454^{+0.045}_{-0.029}$	$4.957^{+0.050}_{-0.032}$	[33] PINEDA	00	THEO
4.25 ± 0.08	4.73 ± 0.09	[34] BENEKE	99	THEO
$3.8^{+0.77}_{-2.0}$	$4.23^{+0.86}_{-2.0}$	[35] BRANDENB...	99	
4.25 ± 0.09	4.73 ± 0.10	[36] HOANG	99	THEO
4.2 ± 0.1	4.67 ± 0.11	[37] MELNIKOV	99	THEO
4.21 ± 0.11	4.69 ± 0.12	[38] PENIN	99	THEO
3.91 ± 0.67	4.35 ± 0.75	[39] ABREU	98I	DLPH
4.14 ± 0.04	4.61 ± 0.05	[40] KUEHN	98	THEO
$4.15 \pm 0.05 \pm 0.20$	$4.62 \pm 0.06 \pm 0.22$	[41] GIMENEZ	97	LATT
4.19 ± 0.06	4.66 ± 0.07	[42] JAMIN	97	THEO
$4.16 \pm 0.32 \pm 0.60$	$4.63 \pm 0.36 \pm 0.67$	[43] RODRIGO	97	THEO

[1] CHETYRKIN 09 determine m_c and m_b from the $e^+ e^- \rightarrow Q\overline{Q}$ cross-section and sum rules, using a four-loop computation of the heavy quark vacuum polarization. We have converted their m_b to the 1S scheme.

[2] ABDALLAH 08D determine $\overline{m}_b(M_Z) = 3.76 \pm 1.0$ GeV from a leading order study of four-jet rates at LEP. We have converted this to $\overline{m}_b(\overline{m}_b)$ and m_b^{1S}.

[3] GUAZZINI 08 determine $m_b(m_b)$ from a quenched lattice simulation of heavy meson masses. The ± 0.08 is an estimate of the quenching error. We have converted these values to the 1S scheme.

[4] SCHWANDA 08 measure moments of the inclusive photon spectrum in $B \rightarrow X_s \gamma$ decay to determine m_b^{1S}. We have converted this to $\overline{\text{MS}}$ scheme.

[5] DELLA-MORTE 07 determine $\overline{m}_b(\overline{m}_b)$ from a computation of the spin-averaged B meson mass using quenched lattice HQET at order $1/m$. The ± 0.08 is an estimate of the quenching error.

[6] KUHN 07 determine $\overline{m}_b(\mu = 10 \text{ GeV}) = 3.609 \pm 0.025$ GeV and $\overline{m}_b(\overline{m}_b)$ from a four-loop sum-rule computation of the cross-section for $e^+ e^- \rightarrow$ hadrons in the bottom threshold region. We have converted this to the 1S scheme.

[7] ABDALLAH 06D determine $m_b(M_Z) = 2.85 \pm 0.32$ GeV from Z-decay three-jet events containing a b-quark. We have converted this to $\overline{m}_b(\overline{m}_b)$ and m_b^{1S}.

[8] BOUGHEZAL 06 $\overline{\text{MS}}$ scheme result comes from the first moment of the hadronic production cross-section to order α_s^3. We have converted it to the 1S scheme.

[9] BUCHMULLER 06 determine m_b and m_c by a global fit to inclusive B decay spectra. We have converted this to the 1S scheme.

[10] PINEDA 06 $\overline{\text{MS}}$ scheme result comes from a partial NNLL evaluation (complete at NNLO) of sum rules of the bottom production cross-section in $e^+ e^-$ annihilation. We have converted it to the 1S scheme.

[11] GRAY 05 determines $\overline{m}_b(\overline{m}_b)$ from a lattice computation of the Υ spectrum. The simulations have 2+1 dynamical light flavors. The b quark is implemented using NRQCD.

[12] We have converted m_b to the 1S scheme.

[13] AUBERT 04X obtain m_b from a fit to the hadron mass and lepton energy distributions in semileptonic B decay. The paper quotes values in the kinetic scheme. The $\overline{\text{MS}}$ value

has been provided by the BABAR collaboration, and we have converted this to the 1S scheme.

[14] BAUER 04 determine m_b, m_c and $m_b - m_c$ by a global fit to inclusive B decay spectra.

[15] HOANG 04 determines m_b ($\overline{m}_b$) from moments at order α_s^2 of the bottom production cross-section in $e^+ e^-$ annihilation.

[16] MCNEILE 04 use lattice QCD with dynamical light quarks and a static heavy quark to compute the masses of heavy-light mesons.

[17] BAUER 03 determine the b quark mass by a global fit to B decay observables. The experimental data includes lepton energy and hadron invariant mass moments in semileptonic $B \rightarrow X_c \ell \nu_\ell$ decay, and the inclusive photon spectrum in $B \rightarrow X_s \gamma$ decay. The theoretical expressions used are of order $1/\mathrm{m}^3$, and $\alpha_s^2 \beta_0$.

[18] BORDES 03 determines m_b using QCD finite energy sum rules to order α_s^2.

[19] CORCELLA 03 determines $\overline{m}_b$ using sum rules computed to order α_s^2. Includes charm quark mass effects.

[20] DEDIVITIIS 03 use a quenched lattice computation of heavy-heavy and heavy-light meson masses.

[21] EIDEMULLER 03 determines $\overline{m}_b$ and $\overline{m}_c$ using QCD sum rules.

[22] ERLER 03 determines $\overline{m}_b$ and $\overline{m}_c$ using QCD sum rules. Includes recent BES data.

[23] MAHMOOD 03 determines m_b^{1S} by a fit to the lepton energy moments in $B \rightarrow X_c \ell \nu_\ell$ decay. The theoretical expressions used are of order $1/\mathrm{m}^3$ and $\alpha_s^2 \beta_0$. We have converted their result to the $\overline{\mathrm{MS}}$ scheme.

[24] BRAMBILLA 02 determine $\overline{m}_b(\overline{m}_b)$ from a computation of the $\Upsilon(1S)$ mass to order α_s^4, including finite m_c corrections. We have converted this to the 1S scheme.

[25] PENIN 02 determines $\overline{m}_b$ from the spectrum of the Υ system.

[26] NARISON 01B uses pseudoscalar sum rules in the B and D meson channels.

[27] PINEDA 01 uses the $\Upsilon(1S)$ system to determine the quark mass. The errors are due to theory, and the uncertainty in α_s.

[28] ABBIENDI 01S find $\overline{m}_b$ (M_Z) to be 2.67 ± 0.4 GeV from an analysis of $Z \rightarrow b$ decays.

[29] BRAMBILLA 01 determine $\overline{m}_b(\overline{m}_b)$ from a computation of the J/ψ mass. We have converted this to the 1S scheme.

[30] KUHN 01 uses an analysis of the $e^+ e^-$ total cross section to hadrons.

[31] BARATE 00V obtain the b quark mass $\overline{m}_b(M_Z) = 3.27 \pm 0.22(\mathrm{stat}) \pm 0.22(\mathrm{exp}) \pm 0.38(\mathrm{had}) \pm 0.16(\mathrm{thy})$ from an analysis of event shape variables in Z decays. We have converted this to $\mu = \overline{m}_b$.

[32] HOANG 00 uses a NNLO calculation of the vacuum polarization function to determine spectral moments of the masses and electronic decay widths of the Υ mesons.

[33] LUCHA 00, PINEDA 00 obtain the b-quark mass from a perturbative calculation of the Υ spectrum and decay widths to order α_s^4.

[34] BENEKE 99 uses a calculation of the $b\overline{b}$ production cross section and the mass of the Υ meson at NNLO.

[35] BRANDENBURG 99 obtain a b-quark mass of $\overline{m}_b(M_Z) = 2.56 \pm 0.27 {}^{+0.28}_{-0.38} {}^{+0.49}_{-1.48}$ from a study of three-jet events at the Z. We have converted this to $\mu = \overline{m}_b$.

[36] HOANG 99 uses a NNLO calculation of the vacuum polarization function to determine spectral moments of the masses and electronic decay widths of the Υ mesons.

[37] MELNIKOV 99 compute the quark mass using Υ sum rules at NNLO.

[38] PENIN 99 compute the quark mass using Υ sum rules at NNLO.

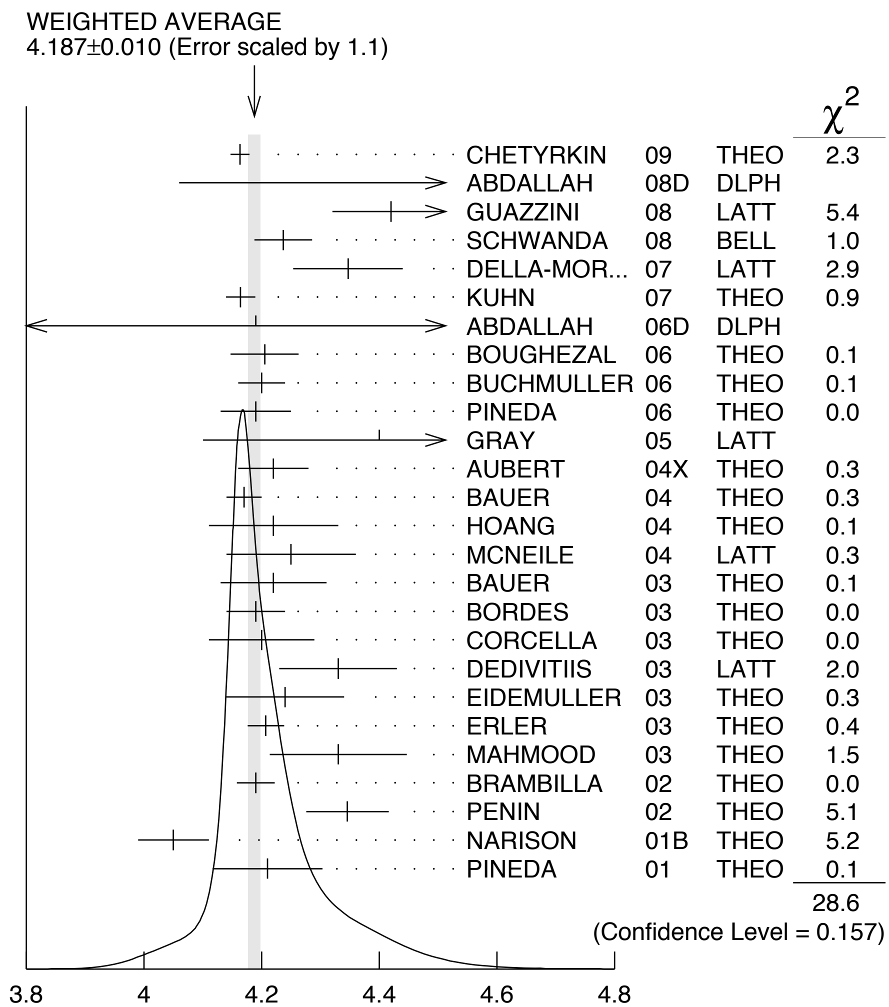
[39] ABREU 98I determines the $\overline{\mathrm{MS}}$ mass $\overline{m}_b = 2.67 \pm 0.25 \pm 0.34 \pm 0.27$ GeV at $\mu = M_Z$ from three jet heavy quark production at LEP. ABREU 98I have rescaled the result to $\mu = \overline{m}_b$ using $\alpha_s = 0.118 \pm 0.003$.

[40] KUEHN 98 uses a calculation of the vacuum polarization function, including resumming threshold effects, to determine spectral moments of the masses of the Υ mesons. We have converted their extracted value of 4.75 ± 0.04 for the pole mass to the $\overline{\mathrm{MS}}$ scheme.

[41] GIMENEZ 97 uses lattice computations of the B-meson propagator and the B-meson binding energy $\overline{\Lambda}$ in the HQET. Their systematic (second) error for the $\overline{\text{MS}}$ mass is an estimate of the effects of higher-order corrections in the matching of the HQET operators (renormalon effects).

[42] JAMIN 97 apply the QCD moment method to the Υ system. They also find a pole mass of 4.60 $\pm$ 0.02.

[43] RODRIGO 97 determines the $\overline{\text{MS}}$ mass $\overline{m}_b = 2.85 \pm 0.22 \pm 0.20 \pm 0.36$ GeV at $\mu{=}M_Z$ from three jet heavy quark production at LEP. We have rescaled the result.



b-QUARK $\overline{\text{MS}}$ MASS (GeV)

b-QUARK REFERENCES

CHETYRKIN	09	PR D80 074010	K.G. Chetyrkin *et al.*	(KARL, BNL)
ABDALLAH	08D	EPJ C55 525	J. Abdallah *et al.*	(DELPHI Collab.)
GUAZZINI	08	JHEP 0801 076	D. Guazzini, R. Sommer, N. Tantalo	
SCHWANDA	08	PR D78 032016	C. Schwanda *et al.*	(BELLE Collab.)
DELLA-MOR...	07	JHEP 0701 007	M. Della Morte *et al.*	
KUHN	07	NP B778 192	J.H. Kuhn, M. Steinhauser, C. Sturm	
ABDALLAH	06D	EPJ C46 569	J. Abdallah *et al.*	(DELPHI Collab.)
BOUGHEZAL	06	PR D74 074006	R. Boughezal, M. Czakon, T. Schutzmeier	
BUCHMULLER	06	PR D73 073008	O.L. Buchmuller, H.U. Flacher	
PINEDA	06	PR D73 111501R	A. Pineda, A. Signer	

GRAY	05	PR D72 094507	A. Gray *et al.*	(HPQCD, UKQCD Collab.)
AUBERT	04X	PRL 93 011803	B. Aubert *et al.*	(BABAR Collab.)
BAUER	04	PR D70 094017	C. Bauer *et al.*	
HOANG	04	PL B594 127	A.H. Hoang, M. Jamin	
MCNEILE	04	PL B600 77	C. McNeile, C. Michael, G. Thompson	(UKQCD Collab.)
BAUER	03	PR D67 054012	C.W. Bauer *et al.*	
BORDES	03	PL B562 81	J. Bordes, J. Penarrocha, K. Schilcher	
CORCELLA	03	PL B554 133	G. Corcella, A.H. Hoang	
DEDIVITIIS	03	NP B675 309	G.M. de Divitiis *et al.*	
EIDEMULLER	03	PR D67 113002	M. Eidemuller	
ERLER	03	PL B558 125	J. Erler, M. Luo	
MAHMOOD	03	PR D67 072001	A.H. Mahmood *et al.*	(CLEO Collab.)
BRAMBILLA	02	PR D65 034001	N. Brambilla, Y. Sumino, A. Vairo	
EL-KHADRA	02	ARNPS 52 201	A.X. El-Khadra, M. Luke	
PENIN	02	PL B538 335	A. Penin, M. Steinhauser	
ABBIENDI	01S	EPJ C21 411	G. Abbiendi *et al.*	(OPAL Collab.)
BRAMBILLA	01	PL B513 381	N. Brambilla, Y. Sumino, A. Vairo	
KUHN	01	NP B619 588	J.H. Kuhn, M. Steinhauser	
NARISON	01B	PL B520 115	S. Narison	
PINEDA	01	JHEP 0106 022	A. Pineda	
BARATE	00V	EPJ C18 1	R. Barate *et al.*	(ALEPH Collab.)
HOANG	00	PR D61 034005	A.H .Hoang	
LUCHA	00	PR D62 097501	W. Lucha, F.F. Schoeberl	
PINEDA	00	PR D61 077505	A. Pineda, F.J. Yndurain	
BENEKE	99	PL B471 233	M. Beneke, A. Signer	
BRANDENB...	99	PL B468 168	A. Brandenburg *et al.*	
HOANG	99	PR D59 014039	A.H. Hoang	
MELNIKOV	99	PR D59 114009	K. Melnikov, A. Yelkhovsky	
PENIN	99	NP B549 217	A.A. Penin, A.A. Pivovarov	
ABREU	98I	PL B418 430	P. Abreu *et al.*	(DELPHI Collab.)
KUEHN	98	NP B534 356	J.H. Kuehn, A.A. Penin, A.A. Pivovarov	
GIMENEZ	97	PL B393 124	V. Gimenez, G. Martinelli, C.T. Sachrajda	
JAMIN	97	NP B507 334	M. Jamin, A. Pich	
RODRIGO	97	PRL 79 193	G. Rodrigo, A. Santamaria, M.S. Bilenky	