b

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

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

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b-QUARK MASS

The first value is the "running mass" $\overline{m}_b(\mu = \overline{m}_b)$ in the $\overline{\mathrm{MS}}$ 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 $\overline{\mathrm{MS}}$ mass because it gives a stable perturbative expansion. We have converted masses in other schemes to the $\overline{\mathrm{MS}}$ mass and *1S* mass using two-loop QCD perturbation theory with $\alpha_s(\mu = \overline{m}_b) = 0.223 \pm 0.008$. The values $4.18^{+0.04}_{-0.03}$ GeV for the $\overline{\mathrm{MS}}$ mass and $4.66^{+0.04}_{-0.03}$ GeV for the *1S* mass correspond to 4.78 ± 0.06 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."

$\overline{\mathrm{MS}}$ *MASS* (GeV)	*1S MASS* (GeV)	*DOCUMENT ID*	*TECN*
$\mathbf{4.18\,^{+0.04}_{-0.03}}$	**OUR EVALUATION** of $\overline{\mathrm{MS}}$ Mass. See the ideogram below.		
$\mathbf{4.66\,^{+0.04}_{-0.03}}$	**OUR EVALUATION** of $1S$ Mass. See the ideogram below.		
4.197 ± 0.022	4.671 ± 0.024	[1] KIYO 16	THEO
4.183 ± 0.037	4.656 ± 0.041	[2] ALBERTI 15	THEO
$4.193^{+0.022}_{-0.035}$	$4.667^{+0.024}_{-0.039}$	[3] BENEKE 15	THEO
4.176 ± 0.023	4.648 ± 0.026	[4] DEHNADI 15	THEO
4.07 ± 0.17	4.53 ± 0.19	[5] ABRAMOWICZ 14A	HERA
4.201 ± 0.043	4.676 ± 0.048	[6] AYALA 14A	THEO
4.21 ± 0.11	4.69 ± 0.12	[7] BERNARDONI 14	LATT
$4.169 \pm 0.002 \pm 0.008$	$4.640 \pm 0.002 \pm 0.009$	[8] PENIN 14	THEO
4.166 ± 0.043	4.637 ± 0.048	[9] LEE 13O	LATT
4.247 ± 0.034	4.727 ± 0.039	[10] LUCHA 13	THEO
4.236 ± 0.069	4.715 ± 0.077	[11] NARISON 13	THEO
4.213 ± 0.059	4.689 ± 0.066	[12] NARISON 13A	THEO
4.171 ± 0.009	4.642 ± 0.010	[13] BODENSTEIN 12	THEO
4.29 ± 0.14	4.77 ± 0.16	[14] DIMOPOUL... 12	LATT
$4.235 \pm 0.003 \pm 0.055$	$4.755 \pm 0.003 \pm 0.058$	[15] HOANG 12	THEO
4.177 ± 0.011	4.649 ± 0.012	[16] NARISON 12	THEO
$4.18\,^{+0.05}_{-0.04}$	$4.65^{+0.06}_{-0.04}$	[17] LASCHKA 11	THEO
$4.186 \pm 0.044 \pm 0.015$	$4.659 \pm 0.050 \pm 0.017$	[18] AUBERT 10A	BABR
4.164 ± 0.023	4.635 ± 0.026	[19] MCNEILE 10	LATT
4.163 ± 0.016	4.633 ± 0.018	[20] CHETYRKIN 09	THEO
4.243 ± 0.049	4.723 ± 0.055	[21] SCHWANDA 08	BELL

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

4.212±0.032	4.688 ± 0.036	[22] NARISON	12	THEO
4.171±0.014	4.642 ± 0.016	[23] NARISON	12A	THEO
4.173±0.010	4.645 ± 0.011	[24] NARISON	10	THEO
5.26 ±1.2	5.85 ± 1.3	[25] ABDALLAH	08D	DLPH
4.42 ±0.06 ±0.08	4.92 ± 0.07 ± 0.09	[26] GUAZZINI	08	LATT
4.347±0.048±0.08	4.838 ± 0.053 ± 0.09	[27] DELLA-MOR...	07	LATT
4.164±0.025	4.635 ± 0.028	[28] KUHN	07	THEO
4.19 ±0.40	4.66 ± 0.45	[29] ABDALLAH	06D	DLPH
4.205±0.058	4.68 ± 0.06	[30] BOUGHEZAL	06	THEO
4.20 ±0.04	4.67 ± 0.04	[31] BUCHMUEL...	06	THEO
4.19 ±0.06	4.66 ± 0.07	[32] PINEDA	06	THEO
4.4 ±0.3	4.9 ± 0.3	[33,34] GRAY	05	LATT
4.22 ±0.06	4.72 ± 0.07	[35] AUBERT	04X	THEO
4.17 ±0.03	4.68 ± 0.03	[36] BAUER	04	THEO
4.22 ±0.11	4.72 ± 0.12	[34,37] HOANG	04	THEO
4.25 ±0.11	4.76 ± 0.12	[34,38] MCNEILE	04	LATT
4.22 ±0.09	4.74 ± 0.10	[39] BAUER	03	THEO
4.19 ±0.05	4.66 ± 0.05	[40] BORDES	03	THEO
4.20 ±0.09	4.67 ± 0.10	[41] CORCELLA	03	THEO
4.33 ±0.10	4.84 ± 0.11	[34,42] DEDIVITIIS	03	LATT
4.24 ±0.10	4.72 ± 0.11	[43] EIDEMULLER	03	THEO
4.207±0.031	4.682 ± 0.035	[44] ERLER	03	THEO
4.33 ±0.06 ±0.10	4.82 ± 0.07 ± 0.11	[45] MAHMOOD	03	CLEO
4.190±0.032	4.663 ± 0.036	[46] BRAMBILLA	02	THEO
4.346±0.070	4.837 ± 0.078	[47] PENIN	02	THEO

[1] KIYO 16 determine $\overline{m}_b(\overline{m}_b)$ from the $\Upsilon(1S)$ mass at order α_s^3 (N3LO). We have converted this to the 1S scheme.

[2] ALBERTI 15 determine $\overline{m}_b(\overline{m}_b)$ from fits to inclusive $B \rightarrow X_c e \overline{\nu}$ decay. We have converted this to the 1S scheme. They also find $m_b^{\text{kin}}(1\ \text{GeV}) = 4.553 \pm 0.020$ GeV.

[3] BENEKE 15 determine $\overline{m}_b(\overline{m}_b)$ using sum rules for $e^+ e^- \rightarrow$ hadrons at order N3LO including finite m_c effects. We have converted this to the 1S scheme. They also find $m_b^{\text{PS}}(2\ \text{GeV}) = 4.532^{+0.013}_{-0.039}$ GeV. When the four-loop conversion between the pole and the $\overline{\text{MS}}$ mass is applied in BENEKE 16, the $\overline{m}_b(\overline{m}_b)$ mass changes to $4.203^{+0.016}_{-0.034}$ GeV.

[4] DEHNADI 15 determine $\overline{m}_b(\overline{m}_b)$ using sum rules for $e^+ e^- \rightarrow$ hadrons at order α_s^3 (N3LO), and fitting to both experimental data and lattice results. We have converted this to the 1S scheme.

[5] ABRAMOWICZ 14A determine $\overline{m}_b(\overline{m}_b) = 4.07 \pm 0.14^{+0.01}_{-0.07}{}^{+0.05}_{-0.00}{}^{+0.08}_{-0.05}$ from the production of b quarks in $e p$ collisions at HERA. The errors due to fitting, modeling, PDF parameterization, and theoretical QCD uncertainties due to the values of α_s, m_c, and the renormalization scale μ have been combined in quadrature. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[6] AYALA 14A determine $\overline{m}_b(\overline{m}_b)$ from the $\Upsilon(1S)$ mass computed to N^{3}LO order in perturbation theory using a renormalon subtracted scheme. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[7] BERNARDONI 14 determine m_b from $N_f = 2$ lattice calculations using heavy quark effective theory non-perturbatively renormalized and matched to QCD at $1/m$ order. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[8] PENIN 14 determine $\overline{m}_b(\overline{m}_b) = 4.169 \pm 0.008 \pm 0.002 \pm 0.002$ using an estimate of the order α_s^3 b-quark vacuum polarization function in the threshold region, including finite m_c effects. The errors of ± 0.008 from theoretical uncertainties, and ± 0.002 from α_s have been combined in quadrature. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[9] LEE 13O determines m_b using lattice calculations of the Υ and B_s binding energies in NRQCD, including three light dynamical quark flavors. The quark mass shift in NRQCD is determined to order α_s^2, with partial α_s^3 contributions.

[10] LUCHA 13 determines m_b from QCD sum rules for heavy-light currents using the lattice value for f_B of 191.5 ± 7.3 GeV.

[11] NARISON 13 determines m_b using QCD spectral sum rules to order α_s^2 (NNLO) and including condensates up to dimension 6. We have converted the $\overline{\text{MS}}$ value to the 1S scheme.

[12] NARISON 13A determines m_b using HQET sum rules to order α_s^2 (NNLO) and the B meson mass and decay constant.

[13] BODENSTEIN 12 determine m_b using sum rules for the vector current correlator and the $e^+ e^- \to Q\overline{Q}$ total cross-section. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[14] DIMOPOULOS 12 determine quark masses from a lattice computation using $N_f = 2$ dynamical flavors of twisted mass fermions. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[15] HOANG 12 determine m_b using non-relativistic sum rules for the Υ system at order α_s^2 (NNLO) with renormalization group improvement.

[16] Determines m_b to order α_s^3 (N3LO), including the effect of gluon condensates up to dimension eight combining the methods of NARISON 12 and NARISON 12A. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[17] LASCHKA 11 determine the b mass from the charmonium spectrum. The theoretical computation uses the heavy $Q\overline{Q}$ potential to order $1/m_Q$ obtained by matching the short-distance perturbative result onto lattice QCD result at larger scales. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[18] AUBERT 10A determine the b- and c-quark masses from a fit to the inclusive decay spectra in semileptonic B decays in the kinetic scheme (and convert it to the $\overline{\text{MS}}$ scheme). We have converted this to the 1S scheme.

[19] MCNEILE 10 determines m_b by comparing order α_s^3 (N3LO) perturbative results for the pseudo-scalar current to lattice simulations with $N_f = 2+1$ sea-quarks by the HPQCD collaboration. We have converted $\overline{m}_b$ $(\overline{m}_b)$ to the 1S scheme.

[20] CHETYRKIN 09 determine m_c and m_b from the $e^+ e^- \to Q\overline{Q}$ cross-section and sum rules, using an order α_s^3 (N3LO) computation of the heavy quark vacuum polarization. We have converted their m_b to the 1S scheme.

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

[22] NARISON 12 determines m_b using exponential sum rules for the vector current correlator to order α_s^3, including the effect of gluon condensates up to dimension eight. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[23] NARISON 12A determines m_b using sum rules for the vector current correlator to order α_s^3, including the effect of gluon condensates up to dimension eight. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[24] NARISON 10 determines m_b from ratios of moments of vector current correlators computed to order α_s^3 and including the dimension-six gluon condensate. These values are taken from the erratum to that reference.

[25] 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}.

[26] GUAZZINI 08 determine $\overline{m}_b(\overline{m}_b)$ 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 1*S* scheme.

[27] 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.

[28] 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.

[29] 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}.

[30] 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.

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

[32] PINEDA 06 $\overline{\text{MS}}$ scheme result comes from a partial NNLL evaluation (complete at order α_s^2 (NNLO)) of sum rules of the bottom production cross-section in $e^+ e^-$ annihilation. We have converted it to the 1S scheme.

[33] 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.

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

[35] 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.

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

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

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

[39] 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 $1/\text{m}^3$, and $\alpha_s^2 \beta_0$.

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

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

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

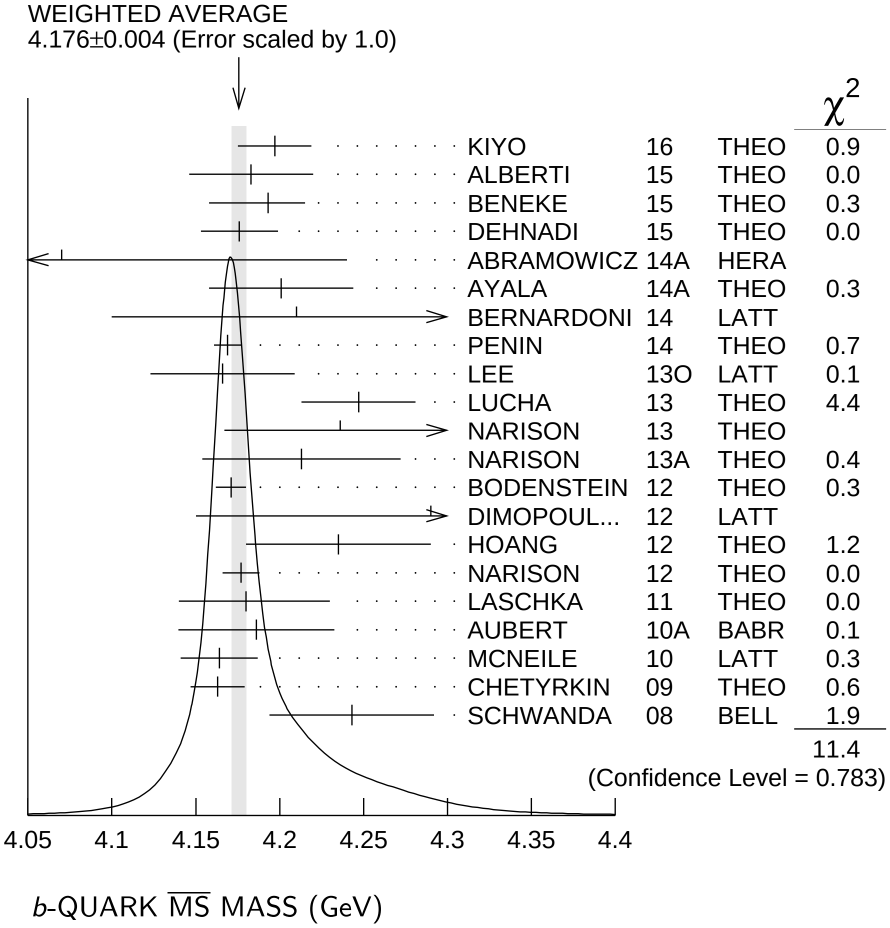
[43] EIDEMULLER 03 determines $\overline{m}_b$ and $\overline{m}_c$ using QCD sum rules.

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

[45] 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 $1/\text{m}^3$ and $\alpha_s^2 \beta_0$. We have converted their result to the $\overline{\text{MS}}$ scheme.

[46] 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.

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



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