QUARKS

The *u*-, *d*-, and *s*-quark masses are estimates of so-called "current-quark masses," in a mass-independent subtraction scheme such as $\overline{\mathrm{MS}}$ at a scale $\mu \approx 2$ GeV. The *c*- and *b*-quark masses are the "running" masses in the $\overline{\mathrm{MS}}$ scheme. For the *b*-quark we also quote the 1S mass. These can be different from the heavy quark masses obtained in potential models.

u

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

$m_u = 2.2^{+0.6}_{-0.4}$ MeV Charge $= \frac{2}{3}\ e$ $I_z = +\frac{1}{2}$

$m_u/m_d = 0.38$–0.58

d

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

$m_d = 4.7^{+0.5}_{-0.4}$ MeV Charge $= -\frac{1}{3}\ e$ $I_z = -\frac{1}{2}$

$m_s/m_d = 17$–22

$\overline{m} = (m_u + m_d)/2 = 3.5^{+0.7}_{-0.3}$ MeV

s

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

$m_s = 96^{+8}_{-4}$ MeV Charge $= -\frac{1}{3}\ e$ Strangeness $= -1$

$m_s \ / \ ((m_u + m_d)/2) = 27.3 \pm 0.7$

c

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

$m_c = 1.28 \pm 0.03$ GeV Charge $= \frac{2}{3}\ e$ Charm $= +1$

$m_c/m_s = 11.72 \pm 0.25$

$m_b/m_c = 4.53 \pm 0.05$

$m_b - m_c = 3.45 \pm 0.05$ GeV

b

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

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

Mass $m = 4.18^{+0.04}_{-0.03}$ GeV Charge $= -\frac{1}{3}\ e$ Bottom $= -1$

t

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

Charge $= \frac{2}{3}\ e$ Top $= +1$

Mass (direct measurements) $m = 173.1 \pm 0.6$ GeV [a,b] (S = 1.6)
Mass from cross-section measurements) $m = 160^{+5}_{-4}$ GeV [a]
Mass (Pole from cross-section measurements) $m = 173.5 \pm 1.1$ GeV
$m_t - m_{\overline{t}} = -0.2 \pm 0.5$ GeV (S = 1.1)
Full width $\Gamma = 1.41^{+0.19}_{-0.15}$ GeV (S = 1.4)
$\Gamma\big(W b\big)/\Gamma\big(W q(q = b,\ s,\ d)\big) = 0.957 \pm 0.034$ (S = 1.5)

t-quark EW Couplings

$F_0 = 0.685 \pm 0.020$
$F_- = 0.320 \pm 0.013$
$F_+ = 0.002 \pm 0.011$
$F_{V+A} < 0.29$, CL = 95%

t DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	*p* (MeV/*c*)
$t \rightarrow W q(q = b,\ s,\ d)$				–
$t \rightarrow W b$				–
$t \rightarrow \ell \nu_\ell$ anything	[c,d]	(9.4±2.4) %		–
$t \rightarrow e \nu_e b$		(13.3±0.6) %		–
$t \rightarrow \mu \nu_\mu b$		(13.4±0.6) %		–
$t \rightarrow q \overline{q} b$		(66.5±1.4) %		–
$\Delta T = 1$ weak neutral current (*T1*) modes				
$t \rightarrow Z q(q{=}u,c)$	*T1* [e]	$< 5 \times 10^{-4}$	95%	–
$t \rightarrow \ell^+ \overline{q} \overline{q}'(q{=}d,s,b;\ q'{=}u,c)$		$< 1.6 \times 10^{-3}$	95%	–

b′ (4*th* Generation) Quark, Searches for

Mass $m >$ 190 GeV, CL = 95% ($p\overline{p}$, quasi-stable b')
Mass $m >$ 755 GeV, CL = 95% (pp, neutral-current decays)
Mass $m >$ 675 GeV, CL = 95% (pp, charged-current decays)
Mass $m >$ 46.0 GeV, CL = 95% ($e^+ e^-$, all decays)

t' (4^{th} Generation) Quark, Searches for

$m(t'(2/3)) >$ 782 GeV, CL = 95% (neutral-current decays)
$m(t'(2/3)) >$ 700 GeV, CL = 95% (charged-current decays)
$m(t'(5/3)) >$ 800 GeV, CL = 95%

Free Quark Searches

All searches since 1977 have had negative results.

NOTES

[*a*] A discussion of the definition of the top quark mass in these measurements can be found in the review "The Top Quark."

[*b*] Based on published top mass measurements using data from Tevatron Run-I and Run-II and LHC at $\sqrt{s} = 7$ TeV. Including the most recent unpublished results from Tevatron Run-II, the Tevatron Electroweak Working Group reports a top mass of 173.2 ± 0.9 GeV. See the note "The Top Quark' in the Quark Particle Listings of this *Review*.

[*c*] ℓ means e or μ decay mode, not the sum over them.

[*d*] Assumes lepton universality and W-decay acceptance.

[*e*] This limit is for $\Gamma(t \to Z q)/\Gamma(t \to W b)$.