

QUARKS

The u -, d -, and s -quark masses are the $\overline{MS}$ masses at the scale $\mu = 2$ GeV. The c - and b -quark masses are the $\overline{MS}$ masses renormalized at the $\overline{MS}$ mass, i.e. $\overline{m} = \overline{m}(\mu = \overline{m})$. The t -quark mass is extracted from event kinematics (see the review "The Top Quark").

u

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

$$m_u = 2.16 \pm 0.07 \text{ MeV, CL} = 90\% \quad \text{Charge} = \frac{2}{3} e \quad I_z = +\frac{1}{2}$$

$$m_u/m_d = 0.462 \pm 0.020, \text{ CL} = 90\%$$

NODE=Q002

 NODE=Q002M;DTYPE=M;OUR EVAL;
 → UNCHECKED ←
 NODE=Q002MR;DTYPE=z;OUR EVAL;
 → UNCHECKED ←

d

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

$$m_d = 4.70 \pm 0.07 \text{ MeV, CL} = 90\% \quad \text{Charge} = -\frac{1}{3} e \quad I_z = -\frac{1}{2}$$

$$m_s/m_d = 17-22$$

$$\overline{m} = (m_u + m_d)/2 = 3.49 \pm 0.07 \text{ MeV, CL} = 90\%$$

NODE=Q001

 NODE=Q001M;DTYPE=M;OUR EVAL;
 → UNCHECKED ←
 NODE=Q001MR;DTYPE=z;OUR EVAL;
 → UNCHECKED ←
 NODE=Q001MR4;DTYPE=z;OUR EVAL;
 → UNCHECKED ←

s

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

$$m_s = 93.5 \pm 0.8 \text{ MeV, CL} = 90\% \quad \text{Charge} = -\frac{1}{3} e \quad \text{Strangeness} = -1$$

$$m_s / ((m_u + m_d)/2) = 27.33^{+0.18}_{-0.14}, \text{ CL} = 90\%$$

NODE=Q003

 NODE=Q003M;DTYPE=M;OUR EVAL;
 → UNCHECKED ←
 NODE=Q003MR2;DTYPE=z;OUR EVAL;
 → UNCHECKED ←

c

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

$$m_c = 1.2730 \pm 0.0046 \text{ GeV, CL} = 90\% \quad \text{Charge} = \frac{2}{3} e \quad \text{Charm} = +1$$

$$m_b - m_c = 3.45 \pm 0.05 \text{ GeV}$$

NODE=Q004

 NODE=Q004M;DTYPE=M;OUR EVAL;
 → UNCHECKED ←
 NODE=Q004MR;DTYPE=a;OUR EVAL;
 → UNCHECKED ←

b

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

$$m_b = 4.183 \pm 0.007 \text{ GeV, CL} = 90\% \quad \text{Charge} = -\frac{1}{3} e \quad \text{Bottom} = -1$$

NODE=Q005

 NODE=Q005M;DTYPE=M;OUR EVAL;
 → UNCHECKED ←

t

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

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

NODE=Q007

$$\text{Mass (direct measurements)} m = 172.56 \pm 0.31 \text{ GeV}^{[a,b]} \quad (S = 1.6)$$

$$\text{Mass (from cross-section measurements)} m = 162.5^{+2.1}_{-1.5} \text{ GeV}^{[a]}$$

$$\text{Mass (Pole from cross-section measurements)} m = 172.4 \pm 0.7 \text{ GeV}$$

$$m_t - m_{\bar{t}} = -0.15 \pm 0.20 \text{ GeV} \quad (S = 1.1)$$

$$\text{Full width } \Gamma = 1.42^{+0.19}_{-0.15} \text{ GeV} \quad (S = 1.4)$$

$$\Gamma(Wb)/\Gamma(Wq(q = b, s, d)) = 0.957 \pm 0.034 \quad (S = 1.5)$$

t-quark EW Couplings

$$F_0 = 0.693 \pm 0.013$$

$$F_- = 0.315 \pm 0.010$$

$$F_+ = -0.005 \pm 0.007$$

$$F_{V+A} < 0.29, \text{ CL} = 95\%$$

NODE=Q007TP;DTYPE=M;CLUMP=A

NODE=Q007TP2;DTYPE=M;CLUMP=A

NODE=Q007TP4;DTYPE=M;CLUMP=A

NODE=Q007CPT;DTYPE=a;CLUMP=A

NODE=Q007W;DTYPE=G

NODE=Q007R6;DTYPE=r

CLUMP=C

NODE=Q007TV0;DTYPE=c;CLUMP=C

NODE=Q007TVN;DTYPE=c;CLUMP=C

NODE=Q007TVP;DTYPE=c;CLUMP=C

NODE=Q007TV2;DTYPE=c;CLUMP=C

t DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
$W q (q = b, s, d)$				—
$W b$				—
$e \nu_e b$		$(11.10 \pm 0.30) \%$		—
$\mu \nu_\mu b$		$(11.40 \pm 0.20) \%$		—
$\tau \nu_\tau b$		$(10.7 \pm 0.5) \%$		—
$q \bar{q} b$		$(66.5 \pm 1.4) \%$		—
$\gamma q (q=u, c)$	$[c] < 9.5$	$\times 10^{-6}$	95%	—
$a q (q=u, c)$	< 1	$\times 10^{-3}$	95%	—
$\Delta T = 1$ weak neutral current ($T1$) modes				
$Z q (q=u, c)$	$T1$	$[d] < 1.2$	$\times 10^{-4}$	95% —
$H u$	$T1$	< 1.9	$\times 10^{-4}$	95% —
$H c$	$T1$	< 3.4	$\times 10^{-4}$	95% —
$\ell^+ \bar{q} q' (q=d, s, b; q'=u, c)$	$T1$	< 1.6	$\times 10^{-3}$	95% —
Lepton Family number (LF) violating modes				
$e^\pm \mu^\mp c$	LF	< 8.9	$\times 10^{-7}$	95% —
$e^\pm \mu^\mp u$	LF	< 7	$\times 10^{-8}$	95% —
$\mu^\pm \tau^\mp q$	LF	< 8.7	$\times 10^{-7}$	95% —

b' (4^{th} Generation) Quark, Searches for

Mass $m > 190$ GeV, CL = 95% ($p\bar{p}$, quasi-stable b')
 Mass $m > 1390$ GeV, CL = 95% ($B(b' \rightarrow Z b) = 1$)
 Mass $m > 1350$ GeV, CL = 95% ($B(b' \rightarrow W t) = 1$)
 Mass $m > 1570$ GeV, CL = 95% ($B(b' \rightarrow H b) = 1$)
 Mass $m > 46.0$ GeV, CL = 95% ($e^+ e^-$, all decays)

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

$m(t'(2/3)) > 1280$ GeV, CL = 95% ($B(t' \rightarrow Z t) = 1$)
 $m(t'(2/3)) > 1295$ GeV, CL = 95% ($B(t' \rightarrow W b) = 1$)
 $m(t'(2/3)) > 1310$ GeV, CL = 95% (singlet t')
 $m(t'(2/3)) > 1350$ GeV, CL = 95% (t' in a weak isospin doublet (t', b'))
 $m(t'(5/3)) > 1.460 \times 10^3$ GeV, CL = 95% ($t'(5/3) \rightarrow t W^+$)

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] This limit is for $\Gamma(t \rightarrow \gamma q)/\Gamma(t \rightarrow W b)$.

[d] This limit is for $\Gamma(t \rightarrow Z q)/\Gamma(t \rightarrow W b)$.

NODE=Q007240;DESIG=6;OUR EST;
 → UNCHECKED ←
 DESIG=1;OUR EST;→ UNCHECKED ←
 DESIG=9
 DESIG=10
 DESIG=4
 DESIG=11
 DESIG=3
 DESIG=30

NODE=Q007;CLUMP=A
 DESIG=2
 DESIG=12
 DESIG=13
 DESIG=8

NODE=Q007;CLUMP=F
 DESIG=15
 DESIG=16
 DESIG=17

NODE=Q008

NODE=Q008BP3;DTYPE=M;CLUMP=B;
 OUR LIM;→ UNCHECKED ←
 NODE=Q008BP1;DTYPE=M;CLUMP=B;
 OUR LIM;→ UNCHECKED ←
 NODE=Q008BP2;DTYPE=M;CLUMP=B;
 OUR LIM;→ UNCHECKED ←
 NODE=Q008BP4;DTYPE=M;CLUMP=B;
 OUR LIM;→ UNCHECKED ←
 NODE=Q008BPE;DTYPE=M;CLUMP=B

NODE=Q009

NODE=Q009TP1;DTYPE=M;OUR LIM;
 → UNCHECKED ←
 NODE=Q009TP2;DTYPE=M;OUR LIM;
 → UNCHECKED ←
 NODE=Q009TP3;DTYPE=M;OUR LIM;
 → UNCHECKED ←
 NODE=Q009TP4;DTYPE=M;OUR LIM;
 → UNCHECKED ←

NODE=Q009TP5;DTYPE=M

NODE=S027

LINKAGE=REV

LINKAGE=TPM

LINKAGE=TD3

LINKAGE=TD2