QUARKS

The *u*-, *d*-, and *s*-quark masses are the $\overline{\text{MS}}$ masses at the scale $\mu = 2$ GeV. The *c*- and *b*-quark masses are the $\overline{\text{MS}}$ masses renormalized at the $\overline{\text{MS}}$ 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").

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

 $m_u = 2.16 \pm 0.07$ MeV, CL = 90% Charge = $\frac{2}{3} e$ $I_z = +\frac{1}{2}$ $m_u/m_d = 0.462 \pm 0.020$, CL = 90%

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

 $m_d = 4.70 \pm 0.07$ MeV, CL = 90% Charge $= -\frac{1}{3} e$ $I_z = -\frac{1}{2}$ $m_s/m_d = 17-22$ $\overline{m} = (m_u + m_d)/2 = 3.49 \pm 0.07$ MeV, CL = 90%

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

 $m_s=93.5\pm0.8$ MeV, CL = 90% Charge = $-\frac{1}{3}~e~$ Strangeness = $-1~m_s~/~((m_u+m_d)/2)=27.33^{+0.18}_{-0.14},~$ CL = 90%

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

 $m_c = 1.2730 \pm 0.0046$ GeV, CL = 90% Charge = $\frac{2}{3} e$ Charm = +1 $m_b - m_c = 3.45 \pm 0.05$ GeV

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

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

U

d

S

С

b

 $I(J^P) = 0(\frac{1}{2}^+)$ Charge $= \frac{2}{3} e$ Top = +1

Mass (direct measurements) $m = 172.57 \pm 0.29 \text{ GeV} {[a,b]}$ (S = 1.5) Mass (from cross-section measurements) $m = 162.5^{+2.1}_{-1.5} \text{ GeV} {[a]}$ Mass (Pole from cross-section measurements) $m = 172.4 \pm 0.7 \text{ GeV}$ $m_t - m_{\overline{t}} = -0.15 \pm 0.20 \text{ GeV}$ (S = 1.1) Full width $\Gamma = 1.42^{+0.19}_{-0.15} \text{ GeV}$ (S = 1.4) $\Gamma(W b)/\Gamma(W q (q = b, s, d)) = 0.957 \pm 0.034$ (S = 1.5)

t-quark EW Couplings

 $F_0 = 0.693 \pm 0.013$ $F_- = 0.315 \pm 0.010$ $F_+ = -0.005 \pm 0.007$ $F_{V+A} < 0.29, \text{ CL} = 95\%$

t DECAY MODES	Fraction $(\Gamma_i/\Gamma$) Confid	dence level	р (MeV/c)
Wq(q = b, s, d)				_
W b				-
ev _e b	(11.10 ± 0.30) %			
$\mu u_{\mu} b$	(11.40 ± 0.20) %			
$ au u_{ au} \mathbf{b}$	$(10.7 \pm 0.5)\%$ –			
q	(66.5 ±1.4)% -			
$\gamma q(q=u,c)$	[c] < 4.5	imes 10 ⁻⁵	95%	-
$\Delta T = 1$ wea	k neutral current (7	(1) modes		
Zq(q=u,c) The set of the set o	[d] < 1.2	$\times 10^{-4}$	95%	_
Ни Т1	< 1.9	imes 10 ⁻⁴	95%	_
Нс т	< 4.3	imes 10 ⁻⁴	95%	-
$\ell^+ \overline{q} \overline{q}'(q=d,s,b; q'=u,c)$ The set of the set o	< 1.6	imes 10 ⁻³	95%	-
Lepton Family	v number (<i>LF</i>) viola	ting mode	s	
$e^{\pm}\mu^{\mp}c$ LF	< 8.9	imes 10 ⁻⁷		_
$e^{\pm}\mu^{\mp}u$ LF	< 7	imes 10 ⁻⁸		_

b' (4th Generation) Quark, Searches for

Mass m > 190 GeV, CL = 95% $(p \overline{p}, \text{ quasi-stable } b')$ 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% $(e^+e^-, \text{ all decays})$

t' (4th Generation) Quark, Searches for

 $\begin{array}{l} m(t'(2/3)) > \ 1280 \ {\rm GeV}, \ {\rm CL} = 95\% & ({\rm B}(t' \to Z\,t) = 1) \\ m(t'(2/3)) > \ 1295 \ {\rm GeV}, \ {\rm CL} = 95\% & ({\rm B}(t' \to W\,b) = 1) \\ m(t'(2/3)) > \ 1310 \ {\rm GeV}, \ {\rm CL} = 95\% & ({\rm singlet} \ t') \\ m(t'(2/3)) > \ 1350 \ {\rm GeV}, \ {\rm CL} = 95\% & (t' \ {\rm in \ a \ weak \ isospin \ doublet} \ (t',b')) \\ m(t'(5/3)) > \ 1.460 \times 10^3 \ {\rm GeV}, \ {\rm CL} = 95\% & (t'(5/3) \to \ t\,W^+) \end{array}$

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 $\Gamma(t \rightarrow Zq)/\Gamma(t \rightarrow Wb)$.