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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{MS} at a scale $\mu \approx 2$ GeV. The c - and b -quark masses are estimated from charmonium, bottomonium, D , and B masses. They are the “running” masses in the \overline{MS} scheme. These can be different from the heavy quark masses obtained in potential models.

u

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

Mass $m = 1$ to 5 MeV [a]
 $m_u/m_d = 0.2$ to 0.8

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

d

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

Mass $m = 3$ to 9 MeV [a]
 $m_s/m_d = 17$ to 25

$$\text{Charge} = -\frac{1}{3} e \quad I_z = -\frac{1}{2}$$

$$\bar{m} = (m_u + m_d)/2 = 2.5 \text{ to } 6 \text{ MeV}$$

s

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

Mass $m = 75$ to 170 MeV [a]
 $(m_s - (m_u + m_d)/2)/(m_d - m_u) = 34$ to 51

$$\text{Charge} = -\frac{1}{3} e \quad \text{Strangeness} = -1$$

c

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

Mass $m = 1.15$ to 1.35 GeV

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

b

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

Mass $m = 4.0$ to 4.4 GeV

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

t

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

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

Mass $m = 174.3 \pm 5.1$ GeV (direct observation of top events)

Mass $m = 168.2^{+9.6}_{-7.4}$ GeV (Standard Model electroweak fit)

t DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
Wb			—
$\ell\nu_\ell$ anything	[b,c] (9.4±2.4) %		—
$\tau\nu_\tau b$			—
$\gamma q(q=u,c)$	[d] < 3.2 %	95%	—
$\Delta T = 1$ weak neutral current ($T1$) modes			
$Zq(q=u,c)$	$T1$ [e] < 33 %	95%	—

b' (4th Generation) Quark, Searches for

Mass $m > 199$ GeV, CL = 95% ($p\bar{p}$, neutral-current decays)

Mass $m > 128$ GeV, CL = 95% ($p\bar{p}$, charged-current decays)

Mass $m > 46.0$ GeV, CL = 95% (e^+e^- , all decays)

Free Quark Searches

All searches since 1977 have had negative results.

NOTES

[a] The ratios m_u/m_d and m_s/m_d are extracted from pion and kaon masses using chiral symmetry. The estimates of u and d masses are not without controversy and remain under active investigation. Within the literature there are even suggestions that the u quark could be essentially massless. The s -quark mass is estimated from SU(3) splittings in hadron masses.

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

[c] Assumes lepton universality and W -decay acceptance.

[d] This limit is for $\Gamma(t \rightarrow \gamma q)/\Gamma(t \rightarrow Wb)$.

[e] This limit is for $\Gamma(t \rightarrow Zq)/\Gamma(t \rightarrow Wb)$.