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Physics

VARIATION OF TOP QUARK MASS (M_T) WITH QCD SCALE PARAMETERΛAND U-QUARK MASS (M_U)

A.K. Gautam — Deptt. of Physics, R.B.S. College, Agra (U.P.)

Deepak Dubey* — Deptt. of Physics, R.B.S. College, Agra (U.P.) *Corresponding Author

Dr. Pradeep Kumar — Deptt. Of Applied Science, MIET Greater Noida(U.P.)

ABSTRACT Variation of top quark mass mt with QCD scale parameter Λ = 0.1 Gev, =0.15 Gev and =0.3 Gev with up quark mu (0.3285, 0.3286 …. 0.3305). Variation of mt and mu was reported.

KEYWORDS : Mass, QCD scale parameter

INTRODUCTION:

The top quark is a member of the third generation quark doubled model of particle physics.

Top quark case where the experimental data are not yet available, it is desirable to present a formula which can be directly used for the top quark mass determination from the characteristics of the cross section of*tt* production near threshold.

THEORY:

Variation of top quark mass:

It is assumed that start with the expressions for the masses of vector and pseudo-scalar mesons, given by[1]

$$M_V = m_1 + m_2 + c_1\mu^{-1/3} + \frac{1}{6m_1m_2}\left(\frac{16}{3}\pi|\psi(0)|^2 + \frac{C_2}{10}\mu^{1/3}\right) \quad \ldots(1)$$

and

$$M_P = m_1 + m_2 + c_1\mu^{-1/3} - \frac{1}{2m_1m_2}\left(\frac{16}{3}\pi\alpha_s|\psi(0)|^2 + \frac{C_2}{10}\mu^{1/3}\right) \quad \ldots(2)$$

Hence,

$$M_V - M_P = \frac{2}{3m_1m_2}\left(\frac{16}{3}\mu\alpha_s|\psi(0)|^2 + \frac{C_2}{10}\mu^{1/3}\right) \quad \ldots(3)$$

For a meson containing a very heavy quark like the top, it is a good approximation to neglect the spin dependent term in M_V+M_P, so that

$$M_V + M_P \approx 2(m_1 + m_2) + 2C_1\mu^{-1/3} \quad \ldots(3.3)$$

The assumptions above would not effect the result significantly but would simplify the calculations very much. A similar but rather crude approximation was adopted in the work of Frank and O' Donnel[2]. With $|\psi(0)|^2$ = ba μ obtained from scaling[3] and by multiplying Eqn. (3) by Eqn. (2). It is assumed that obtained an expression for 22*VPMM*– which can written in the form -

$$\frac{2C_2}{15}\mu^{-2/3} + \frac{64C_1\pi\alpha_s ba}{9m_1m_2}\mu^{2/3} + \frac{2C_1C_2\mu^{-1}}{15(m_1+m_2)} + \frac{64}{9}\pi\alpha_s ba - M_V^2 - M_P^2 = 0 \quad \ldots(4)$$

For a meson containing *t* and *u* quarks, the assumption m_t>>m_u gives μ=m_u. Hence, for *T* meson, Eqn (4) becomes

$$\alpha m_t^2 + \beta m_t + \gamma = 0 \quad \ldots(5)$$

The solution of which is

$$m_t = \frac{\beta \pm \sqrt{\beta^2 - 4\alpha\gamma}}{2\alpha} \quad \ldots(6)$$

Where

$$\alpha = \frac{2C_2}{15}(m_u)^{-2/3} + \frac{64}{9}\pi\alpha_s ba - (M_V^2 - M_P^2) \quad \ldots(7)$$

$$\beta = \frac{2C_2}{15}(m_u)^{1/3} + \frac{64\pi\alpha_s baC_1}{9}(m_u)^{-1/3} + \frac{2C_1C_2}{15} - (m_u)^{-1}$$

$$+\left\{\frac{64\pi\alpha_s ba}{9} - (M_V^2 - M_P^2)\right\} m_u \quad \ldots(8)$$

and

$$\gamma = \frac{64\pi\alpha_s baC_1}{9}(m_u)^{2/3} \quad \ldots(9)$$

The parameters required (for this analysis are contained from Ref.(1) These are as follows; $m_u = \frac{1}{3}$ Gev; C_1= –0.22559, C_2= –2.12419, b=0.95388 $a=\frac{1}{5}$ 15*a*=(all in Gev units) and QCD scale parameter Λ=0.100 α_s is calculated using the formula[4].

$$\alpha_s = \frac{12\pi}{(33 - 2nf)Ln\left(Q^2/\Lambda^2\right)} \quad \ldots(10)$$

Here $Q = 4u$ and $n_f = 3$ [5]

Eqn.(6) in conjuction with Eqn. (7-10) and the parameters given above give the value of m_t.

RESULTS AND DISCUSSION:

The results of our calculations are presented in Table-1.1.

The variation of top quark mass with the QCD scale parameter and m_u for $M_V^2 - M_P^2$ = 0.56 Gev^2 are presented in Table-1.1. In the column first of the table values of mass of *u* quarks are presented which vary from 0.3285 Gev.to 0.3305Gev. In column Second, Third, Fourth calculated values of mass of top quarks are presented with QCD scale parameter =0.1, =0.15 and =0.3 Gev respectively. From Table we find that the top quark mass is 179.990 Gev. For *u* quark mass equal to 0.3295 Gev in the case of =0.1 Gev, $M_V^2 - M_P^2$ 22*VPMM*–=0.56 Gev^2. This value of top quark mass is in experimental agreement[6]. The table shows that the values 0.15 and 0.3 Gev for are not possible for m_u= 0.3285 to 0.3305 Gev. The Fermilab experiment suggests that the values=0.1 Gev. and m_u =0.3295 Gev are possible choice. Thus we fix the parameters like u-quark mass and the QCD scale parameter. We find that using the standard value of the parameters like , m_u and the experimental value of $M_V^2 - M_P^2$ the top quark mass estimated from the potential model matches well with the recently observed value. The value of the top quark mass comes out to be 179.990 Gev, which tallies with the value of obtained from experimental results[6,7]. Thus we find that it is possible to obtain the present Fermilab prediction on top quark from a QCD based potential model.

Table-1.1: Variationof top quark mass m_t with QCD scale parameter$\Lambda$and m_u

S.No.	m_u (Gev.)	m_t (Gev.)		
		=0.1 Gev	=0.15 Gev	=0.3 Gev
1	0.3285	155.833	1.3795	0.6217
2	0.3286	158.494	1.3789	0.6216
3	0.3287	164.113	1.3782	0.6216
4	0.3288	164.534	1.3776	0.6215
5	0.3289	165.549	1.3769	0.6214
6	0.3290	167.030	1.3762	0.6212
7	0.3291	167.612	1.3756	0.6211
8	0.3292	175.748	1.3749	0.6211
9	0.3293	177.079	1.3742	0.6210
10	0.3294	178.268	1.3736	0.6208

11	0.3295	179.990	1.3729	0.6207
12	0.3296	181.746	1.3723	0.6207
13	0.3297	183.537	1.3716	0.6206
14	0.3298	193.140	1.3710	0.6205
15	0.3299	195.166	1.3703	0.6204
16	0.3300	195.352	1.3696	0.6202
17	0.3301	197.004	1.3690	0.6202
18	0.3302	198.684	1.3683	0.6201
19	0.3303	210.002	1.3677	0.6200
20	0.3304	212.159	1.3672	0.6199
21	0.3305	214.124	1.3666	0.6198

CONCLUSION:

The quark mass are $m_u = 0.3295$ Gev, $m_t = 179.990$ Gev.

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