

hep-ph/9512438 28 Dec 1995

hep-ph/9512438  
THEP-95-4  
December 1995

## $R_b$ and $R_c$ Crises

Frank D. (Tony) Smith, Jr.  
e-mail: [gt0109e@prism.gatech.edu](mailto:gt0109e@prism.gatech.edu)  
and [fsmith@pinet.aip.org](mailto:fsmith@pinet.aip.org)

P. O. Box for snail-mail:

P. O. Box 370, Cartersville, Georgia 30120 USA

WWW URL <http://www.gatech.edu/tsmith/home.html>  
andWWW URL <http://galaxy.cau.edu/tsmith/TShome.html>School of Physics  
Georgia Institute of Technology  
Atlanta, Georgia 30332

### Abstract

The  $R_b$  and  $R_c$  crises described by Kaoru Hagiwara in hep-ph/9512425 [2] can be resolved by the T-quark mass value of 130 GeV and the  $\alpha_s(M_Z)$  value of 0.106 of the  $D_4 - D_5 - E_6$  model described in hep-ph/9501252 [5] and quant-ph/9503009 [6].

---

©1995 Frank D. (Tony) Smith, Jr., Cartersville, Georgia USA

# 1 Introduction.

During 1995, precision electroweak data have confirmed the predictions of the Standard Model, with no new physics, with the possible exception of the two observables  $R_b$  and  $R_c$ .

In his recent review, Kaoru Hagiwara [2] has described the situation in detail, assuming the validity of the CDF value of the Truth quark mass of about 175 GeV.

Hagiwara [2] also notes that, although  $\alpha_s \sim 0.12$  is favored from electroweak data, some low-energy measurements favor lower values  $\alpha_s \sim 0.11$ . (For more extended discussion of the  $\alpha_s$  situation, see Shifman [3].)

The purpose of this paper is to show that the data for  $R_b$  and  $R_c$  are consistent with the Standard Model, as described by the  $D_4 - D_5 - E_6$  model [4, 5, 6], without the need for new physics beyond the Standard Model such as technicolor, extended technicolor, or conventional supersymmetry.

## 2 $R_b$ Crisis.

Kaoru Hagiwara in hep-ph/9512425 [2] says that precision electroweak data imply that  $R_b$ , the partial  $Z_0$  boson width ratio of  $b\bar{b}$  decay to total hadronic decay, is about 3% larger than Standard Model predictions with Truth quark mass in the range of the CDF value of about 175 GeV.

Donoghue, Golowich, and Holstein [1] say (at p. 461)  
"Interestingly, however, a more complete calculation reveals a slight *decrease* to occur in the decay rate  $\Gamma_{Z_0 \rightarrow b\bar{b}}$  as  $m_t$  grows."

Since the  $D_4 - D_5 - E_6$  model [4, 5, 6] predicts a Truth quark Mass of about 130 GeV, as opposed to the CDF value of about 175 GeV, equation 1.17 on p. 436 of [1]

$$\Delta\rho \simeq 0.006 \times \left( \frac{m_t}{140\text{GeV}} \right)^2 \quad (1)$$

and equation 5.19 on p. 461 of [1]

$$(\Delta\rho)_{nonuniv}^b = -\frac{4}{3}\Delta\rho - \frac{\alpha}{4\pi s_w^2} \left( \frac{8}{3} + \frac{1}{6c_w^2} \right) \ln \frac{m_t^2}{M_W^2} \quad (2)$$

can be applied to the  $D_4 - D_5 - E_6$  model [4, 5, 6] to give an  $R_b$  value about 2.5% larger than  $R_b$  based on the CDF value of the Truth quark mass.

This shows that the  $D_4 - D_5 - E_6$  model [4, 5, 6] is consistent with the Standard Model value of  $R_b$ .

### 3 $R_c$ Crisis.

Hagiwara's Fig. 3 [2] shows that if  $R_c$ , the partial  $Z_0$  boson width ratio of  $c\bar{c}$  decay to total hadronic decay, is fixed at the Standard Model value, then the precision electroweak data imply that  $\alpha_s(M_Z)$ , the color force coupling constant at the energy of the  $Z_0$  mass, is about  $0.104 \pm 0.08$ .

Since the  $D_4 - D_5 - E_6$  model [4, 5, 6] value of  $\alpha_s(M_Z)$  is about 0.106, the  $D_4 - D_5 - E_6$  model [4, 5, 6] is consistent with the Standard Model value of  $R_c$ .

## References

- [1] J. Donoghue, E. Golowich, and B. Holstein, *Dynamics of the Standard Model*, Cambridge (1992).
- [2] K. Hagiwara, hep-ph/9512425.
- [3] M. Shifman, hep-ph/9511469.
- [4] F. Smith, WWW URL <http://galaxy.cau.edu/tsmith/TShome.html> and WWW URL <http://www.gatech.edu/tsmith/home.html>.
- [5] F. Smith, *Gravity and the Standard Model with 130 GeV Truth Quark from  $D_4 - D_5 - E_6$  Model using  $3 \times 3$  Octonion Matrices*, preprint: THEP-95-1; hep-ph/9501252.

- [6] F. Smith, *Standard Model plus Gravity from Octonion Creators and An-  
nihilators*, preprint: THEP-95-2; quant-th/9503009.