LEP AND TOP

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Abstract

The talk presented a description of work on electroweak radiative corrections done in collaboration with V.Novikov, A.Rozanov, and M.Vysotsky. The starting point of the approach is the so called $\bar{\alpha}$-Born approximation based on three most accurately measured electroweak observables $\bar{\alpha} \equiv \alpha(m_Z^2)$, G_μ and m_Z - and three parameters, the values of which enter one-loop electroweak radiative corrections: m_t, , m_H and $\hat{\alpha}_s(m_Z^2)$. The strong coupling $\hat{\alpha}_s(m_Z^2)$ determines also the final state gluonic corrections to the Z boson decays into quarks (hadrons). Simple analytical expressions for electroweak corrections were derived and implemented in a computer code LEPTOP (see ref. [1], which contains also a complete list of our papers). The subsequent text is an excerpt from the talk.

The most important experimental achievement of the last years is definitely the discovery of the top quark at the Tevatron and the direct measurement of its mass [2]–[4]. A straightforward averaging of CDF and D0 results gives:

$$m_t(\text{direct}) = 180 \pm 12 \ \text{GeV} \ .$$

It is interesting to compare this direct value of m_t with the indirect one, $m_t(\textit{indirect})$, extracted from the precision electroweak measurements of Z boson decays at LEP [5]–[7] and SLC [8] and also from m_W measurements [9], in the framework of the Minimal Standard Model. The relevant experimental data are presented in the Table 1.

TABLE 1

m_Z (GeV)	Γ_Z (GeV)	σ_h^0 (nb)	R_l
91.1887(22)	2.4971(33)	41.492(81)	20.800(35)
$A_{FB}^{0,l}$	A_τ	A_e	R_b
0.0172(13)	0.140(8)	0.137(9)	0.2204(20)
R_c	$A_{FB}^{0,b}$	$A_{FB}^{(0,c)}$	$\sin^2\theta_{eff}^{lept}$ from Q_{FB}
0.1606(95)	0.1015(36)	0.0760(89)	0.2320(16)
m_W (GeV)	$1 - m_W^2/m_Z^2(\nu N)$	$\sin^2\theta_{eff}^{lept}$ from A_{LR}	
80.33(17)	0.2253(47)	0.2294(10)	

By using the code LEPTOP [1] and the Table 1 as input we get Table 2 as an output: for three fixed values of the higgs mass. (Note that we use $\bar{\alpha} = 1/128.89(9)$ in accord with ref. [10]. The uncertainty (9) in $\bar{\alpha}$ gives an additional uncertainty ± 5 GeV for m_t).

TABLE 2

	m_t (indirect)	$\hat{\alpha}_s(m_Z)$	$\chi^2/d.o.f$
$m_H = 60$ GeV:	160(9)	0.123(4)	13/12
$m_H = 300$ GeV:	180(8)	0.125(4)	15/12
$m_H = 1000$ GeV:	197(8)	0.127(4)	18/12

(Note, that if for m_W we consider only the values 80.41(18) GeV (CDF (95)) and 80.36(36) GeV (UA2 (92)), then the three values of m_t are 161(8), 181(8), and 198(8) GeV, while $\hat{\alpha}_s(m_Z)$ and χ^2 do not change).

Similar results give other codes describing electroweak radiative corrections [11]. Comparison of the LEPTOP with other electroweak codes may be found in ref. [12], the main virtue of LEPTOP being its simplicity.

Comparison of direct and indirect values of the top quark mass demonstrates full agreement with the Minimal Standard Model. As indications of new physics (SUSY?) may serve two discrepancies: 1) $\hat{\alpha}_s(m_Z)$ from Z-decays is larger than that from low energy data (DIS [13] and upsilons [14]) ; 2) the observed decay width $\Gamma(Z \to b\bar{b})$ is by 2σ larger than the MSM theoretical value.

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References

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