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HUNTING THE HIDDEN STANDARD HIGGS

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The existence of the Higgs boson H of the Glashow-Weinberg-Salam (GWS) theory is one of the outstanding miracles of present-day physics.

Recently, a careful evaluation of M_W (mass of the charged gauge boson of the GWS-theory) has been published in Talbe II of[1] in terms of α, G_μ, M_Z with parameters: m_t -mass of heavy up-type quark, and M_H -mass of the Higgs. M_Z is the weak neutral gauge boson mass, G_μ the Fermi constant from muon decay, α the fine-structure constant. Comparing this table with our own results obtained from formulae published some time ago[2,3], we found agreement for <u>all</u> tabulated W -masses in <u>all</u> four published digits. This is an impressive example of the level of reliability being obtained in the calculation of electroweak radiative corrections! Combining this fact with the present trend of vanishing anomalous events in favour of the standard model in UA1 and UA2 results[4] after the Leipzig Conference[5], we feel encouraged to pose the following problem seriously: let us suppose that M_H is too large to allow the production of Higgs bosons before SSC and / or LHC become working. With what accuracy would one be able to predict M_H from radiative corrections - assuming, of course, that the GWS-theory is completely correct in all aspects? This is an ambiguous question in view of the fact that radiative corrections are generally small with the exception of certain QED-terms. For this reason, in most papers on the Higgs search the discussion of radiative corrections is excluded; see, e.g.[6], and refs. cited therein.

What one has to do is the following: Knowing α and G_μ, measure two other parameters $f_{1,2}(M_Z, M_W, \alpha, G_\mu)$ and confront them with the calculated prediction as functions of M_H. Evidently, one has to use those quantities which may be (i) measured and (ii) calculated with highest accessible accuracy. These two demands led us to the choices: $f_1 = M_Z$, $f_2 = \sin^2\theta_W$ as to be measured at LEP and SLC. The calculations rely on the commonly known formulae[7]

$$M_W = \frac{A}{\sin\theta_W}, \quad M_Z = \frac{M_W}{\cos\theta_W}, \quad A = \frac{A_0}{(1-\Delta r)^{1/2}},$$

$$A_0 = \left(\frac{\pi\alpha}{\sqrt{2}\,G_\mu}\right)^{1/2} = 37.281 \text{ GeV}, \quad \Delta r = \frac{\alpha}{4\pi} X .$$

We define $\sin^2\theta_W \equiv 1 - M_W^2/M_Z^2$, where M_W is iteratively determined from α, G_μ, M_Z through

$$M_W = M_Z\left[\frac{1}{2} + \frac{1}{2}\left(1 - 4A^2/M_Z^2\right)^{1/2}\right]^{1/2}$$

and $X(\alpha, M_Z, M_W, m_t, M_H)$ has been taken from refs./2,3/. We used the complete expressions for Δr as functions of m_t and M_H *in our calculation**. To be concrete, we assumed 3 generations of flavor and choose m_t = (35 ± 5) GeV close to UA1 preliminary data/5/.

The figure shows a theoretical prediction of the $\sin^2\theta_W$, M_Z interdependence. Scales have been chosen under the assumption that experimentally the following precisions can be obtained: $\Delta M_Z \sim$ ~100 MeV - this limit is determined by the energy resolution which depends on machine parameters/10/; $\Delta\sin^2\theta_W$ = 0.001 - this error stems from theoretical and experimental uncertainties. The former (~ 0.0006) is mainly due to the hadronic vacuum polarization/11/, the latter (~ 0.0008) may be obtained from measuring the polarization asymmetry at resonance assuming half a million of Z bosons produced/10/. The error bars are drawn to indicate the possibly resulting limits on M_H from the above, standard expectations. As is evident, one is at the border line of definite conclusions. We have estimated that the errors assumed for M_Z and $\sin^2\theta_W$ allow us to distinguish between M_H = 100 GeV and M_H = 1000 GeV with 3σ confidence level. A further factor of 1/2 in both the errore would allow one to measure the Higgs mass M_H with an accuracy (depending on the actual parameters)of, say, ± 100 GeV.

In conclusion, if $M_H \gtrsim M_Z/2$, a determination of the Higgs boson mass from radiative corrections to the dependence of $\sin^2\theta_W$ on M_Z , G_μ , α could serve as a best guess during the years up to operation of LHC and/or SSC.

We are deeply indepted to Prof. D.V.Shirkov who strongly enforced us to study the problem raised in this letter.

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*Of course, the influence of M_H on quantities like M_Z , M_W has been studied by several authors, e.g.,in/7-9/. We are novel in our search for quantitative conclusions on M_H from experimental data.

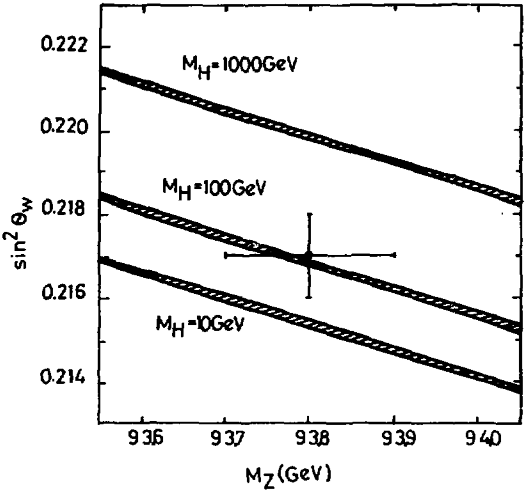

Fig. 1. Graph of $\sin^2\theta_W$ versus M_Z , influenced by M_H through radiative corrections. The thickness corresponds to the range 30 GeV $\leq m_t \leq$ 40 GeV.

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Ахундов А.А., Бардин Д.Ю., Риманн Т. E2-85-454
Поиск скрытого бозона Хиггса

В рамках стандартной теории электрослабых взаимодействий исследуется взаимозависимость M_Z и $\sin^2\theta_W$ с учетом радиационных поправок при фиксированном m_t и различных значениях массы хиггсовского бозона M_H. Показано, что прецизионные измерения M_Z и $\sin^2\theta_W$ на LEP или SLC могут, в принципе, позволить измерить M_H с точностью порядка 100 ГэВ.

Работа выполнена в Лаборатории теоретической физики ОИЯИ.

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Hunting the Hidden Standard Higgs

In the framework of the standard theory of electroweak interactions the M_Z, $\sin^2\theta_W$ interdependence with account of radiative corrections is investigated as a function of the Higgs boson mass at fixed m_t. It is shown that precision measurements of M_Z and $\sin^2\theta_W$ at SLC and LEP will allow one to estimate the Higgs boson mass with an accuracy of about 100 GeV.

The investigation has been performed at the Laboratory of Theoretical Physics, JINR.

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