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Bounds on the Higgs mass in the standard model for one-loop and two-loop effective potentials and their perturbative validity

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Abstract

The purpose of this paper is to obtain the bounds on the Higgs mass in the Standard Model for one and two–loops Higgs potential, which includes the contributions of scalar, vector and fermion loops at one –loop and two-loop levels for a bound on the coupling constant λ given in the work of P. Kielanowski and S.R.Juarez W as $0.369 \le \lambda \le 0.613$. On the basis of these studies, we obtain the upper and lower bounds on the Higgs mass as 143 GeV $\le m_H \le$ 200 GeV. These results will be very useful to LHC experiments for the detection of the Higgs particle and are matching with the results obtained by a few contemporary workers. We also find that the condition for perturbative validity given by Miller is satisfied, when the Higgs mass is calculated perturbatively from the effective potential given by the mass less ϕ^4 theory at one and two-loop level.

Keywords: *Standard model, Bounds on Higgs mass, LHC experiment, Perturbative validity.*

1. Introduction

The Particle physics has set its goal to answering several important questions about the way the universe works. We have so far worked out that there are twelve fundamental matter particles in the universe. Since the new particle accelerator (LHC) has started up at CERN in 2008, it is very much likely that we may see new particles that have not been discovered before. Now, a big question that needs to be answered in particle physics is understanding the origin of mass. It might seem obvious that everything we see around us has a mass, and so feels like it weighs something when we pick it up. But although mass is such a commonly experienced property of matter, one does not really understand how it originates. Actually, the Higgs Boson is the particle that holds the key to the understanding of the origin of mass. It is believed that other particles get mass when they interact with a Higgs particle. The more strongly they interact with the Higgs, the more massive they are. The problem is that the Higgs particle is not seen in any of our experiments, and if we observe it then only we can be sure that we really understand particle mass.

The Standard Model (SM) of particle physics represents an example of calculable quantum field theory.This was achieved after years of efforts of several scientists like S.L.Glashow, S.Weinberg, A.Salam for understanding the theory of electro-weak interaction[1)]. The Standard Model, is being used to describe the fundamental particles (quarks and leptons) and forces. It works extremely well. It has successfully predicted and accounted for the observations of experiments at LEP, the Tevatron at Fermilab and other particle physics experiments. However, it requires the existence of a particle, known as the Higgs boson[2)] . The Higgs mechanism has been introduced in order to give masses to fermions and gauge bosons without violating gauge principles. The introduction of a weak isodoublet of scalar fields gives rise to the physical particle, the Higgs boson. The self-interaction of the scalar field leads to a non-zero field strength in the ground state. Through the interaction with the non-zero Higgs field in the ground state, the electro-weak gauge bosons and the fundamental matter particles acquire their masses. The search for Higgs boson is one of the main goals of present and future high energy colliders[3)]. The observation of this particle is very much important for the understanding of the fundamental interactions among the quarks and leptons, as well as the generation of masses of elementary particles. Actually, in order to understand the unification of well-established electro-magnetic and weak interaction phenomena, the existence of at least one iso-doublet scalar field is needed for the generation of fermion and weak gauge boson masses. In SM, where one iso-doublet scalar field is used, three Goldstone bosons among the four degrees of freedom absorb the longitudinal component of the massive $W^{\pm}$, Z gauge bosons and the degree of freedom that is left over corresponds to a physical scalar particle, called the Higgs particle[2)].

The Higgs boson has been searched at LEP, and its mass should be greater than 114 GeV[3)]. The Higgs particle is very likely to be found in the ensuing experiments at the Large Hadron Collider (LHC) at CERN[3)] .Thus, although the SM has been very much successful in explaining the present data, it will not be taken to be completely tested unless the Higgs particle is experimentally observed .In the SM the properties of the Higgs particle is uniquely determined, once its mass is fixed.Unfortunately the Higgs boson mass is a free parameter of the theory.

One of the main goals of the ensuing experiments at the Large Hadron Collider (LHC) is to search for the Higgs boson. This is the only unconfirmed part of the electroweak sector of the SM. The most crucial part which may guide the experimentalist to its discovery is related to the knowledge of the behavior of the Higgs self-coupling λ, through which the exact mass of the Higgs particle m_H is obtained. The bound on the mass of the Standard Model Higgs boson is an extremely important quantity, especially when the LHC experiments are in progress.

The potential for scalar field is given by $V(\phi) = - \mu^2\ \phi^+\ \phi + \lambda\ (\phi^+\phi)^2$. For positive values of μ^2 and λ, we have spontaneous symmetry breakdown as the scalar develops a vacuum expectation value and $<\phi>_0 = <0|\phi|\ 0> \neq 0$ with $v = (\mu^2/\lambda)^{1/2}$ .The vacuum expectation value has the size $v = 2^{-1/4}\ G_F^{-1/2} \approx 246$ GeV. In the standard model, the physical Higgs scalar particle has the mass given by $m_H = (2\mu^2)^{1/2} = (2\lambda^2)^{1/2}v$. Here the symbols have their usual meaning as given by Cheng and Li[1].

Although there is some knowledge of v, at present there is no information on the quartic coupling λ. Hence there is lack of knowledge of the precise value of the Higgs mass, so that it will be difficult to detect the Higgs particle. There are some predictions on the range of m_H e.g. for $\lambda < 1$ required for perturbative validity, the upper bound on m_H is $m_H <$ 350 Gev. If λ is too small, the symmetry breaking vacuum will be unstable producing a lower bound e.g. the Linde-Weinberg bound. Here the one-loop contributions (specially those due to gauge-boson loop) to the effective potential of path integral formalism of quantum field theory becomes relatively important .The details of the generalization of these calculations for $SU(2) \times U(1)$ is given in the celebrated work of Coleman and Weinberg[4], Weinberg[5], Linde and Weinberg[6].

It may be mentioned that in order to guide the experimentalists in the detection of Higgs particle, bounds on the Higgs mass has been calculated by several authors[4-6].The value of Higgs mass for some particular choice of the parameters have also been calculated. In this context it is important that the effective potentials used in the one or two loop descriptions should be free from false perturbative minima. This is because it has been suggested by Miller[7] that an effective potential evaluated perturbatively can possess false minima, (i.e. non existent minima) because of the approximation method itself. So in this section, we have tried to test the effective potentials used for calculation of Higgs mass for perturbative validity following the work of Miller[7].The effective potential choosen here considers both one and two- loop Higgs potential and includes the effect of scalar, vector and fermion loops to the potential.

Miller wrote the two-loop effective potential by redefining the subtraction point (μ) in a variant the minimal subtraction to obtain[7]

$$V(\phi_{cl}) = \frac{\lambda \phi_{cl}{}^4 S(\phi_{cl})}{4!}$$

where $S(\lambda_{cl})$ is a perturbative series, λ_{cl} is the classical field ($\phi_{cl} = \frac{\delta W[J]}{\delta J}$, W = generator of connected Green function). Using the short hand notations $\alpha = \frac{\lambda}{16\pi^2}$ and $1\phi = \ln\left(\frac{\phi_{cl}^2}{\mu^2}\right)$ Miller showed that one could resume $S(\lambda_{cl})$ perturbation series at u-loop order as

$$S(\phi_{cl}) = \sum_{m=0}^{u} (\alpha 1\phi)^m C_m$$

Now, spontaneous symmetry breaking is indicated by a non-zero (minimal) solution to

$$\frac{dV(\phi_{cl})}{d\phi_{cl}}\ \Big|_{\phi_{cl}=\sigma} = 0$$

On minimizing the effective potential if we find a non-zero vacuum expectation value, then the theory under consideration is said to be spontaneously broken. There exists a problem with the perturbative approach. The question is not about the reliability of the result but whether the indicated spontaneous breaking actually exists or not. In fact, the condition for actual existence of spontaneous symmetry breaking is $|\alpha 1\sigma| < 1$. Actually the approximate nature of perturbation theory can generate false minima to effective potentials. So we try to test the effective potential which is used for calculating Higgs mass bounds for spontaneous symmetry breaking.

The purpose of this paper is to extend the studies on Higgs mass bounds[6] by incorporating the following modifications : (i) our calculation includes the effects of the scalar and fermion loops in addition to the vector loop; (ii) the study is extended to two-loop correction to the potential as given in[7]; (iii) The perturbative validity for one and two-loops Higgs potential, is tested by proving that $|\alpha l_\sigma| <1$ for $\mu^2 \neq 0$..

The paper is organized as follows: in section 2 the theory of the bounds on Higgs mass is given. The theory of perturbative validity for one and two-loop Higgs potentials are given in section 3. The results of the calculations of bounds on Higgs mass and the demonstration of perturbative validity along with discussions are given in section 4 .The conclusions are given in section 5.

2. Theory of Bounds on Higgs Mass

In the Standard model we start with a doublet of complex scalars. Actually, after spontaneous symmetry breaking, three of the original four real scalar fields are eaten by the gauge particles and one is left with one neutral Higgs scalar ϕ^o. The studies on Higgs searches in the Standard Model have been discussed in detail elsewhere[8].In fact the Higgs search is one of the most important aspects of collider physics at the present time and in the near future.

Now, we calculate the modified Linde - Weinberg bound which takes into account the effect of scalar, vector and fermion loops. We start with the equation

$$V(\phi)=V_0(\phi)+V_1(\phi)=-\mu^2\phi^2+\lambda\phi^4+C\phi^4\ln(\frac{\phi^2}{M^2}) \tag{1}$$

where

$$C=\frac{1}{16\pi^2v^4}\left(3\Sigma m_v^4+m_s^4-4\Sigma\, m_f^4\right) \tag{2}$$

Hence, the condition $\left.\frac{\partial V}{\partial\phi}\right|_{\phi=\frac{v}{\sqrt{2}}}=0$ gives

$$-\mu^2+\lambda v^2+Cv^2\{\ln(\frac{v^2}{2M^2})+\frac{1}{2}\}=0 \tag{3}$$

Thus the Higgs mass is given by

$$m_H^2=\frac{1}{2}\frac{\partial^2V}{\partial\phi^2}\ \left|_{\phi=\frac{v}{\sqrt{2}}}\right.=2\lambda v^2+C\,v^2\left\{2\ln\left(\frac{v^2}{2M^2}\right)+3\right\} \tag{4}$$

where μ^2 is substituted from eq.(3). Now, we have

$V\left(\frac{v}{\sqrt{2}}\right)=-\mu^2\frac{v^2}{2}+\frac{Cv^4}{4}+\ln\left(\frac{v^2}{2M^2}\right)$ and $V(0)=0$

Since, $V\left(\frac{v}{\sqrt{2}}\right)<V(0)$, we have

$$\left\{\ln\left(\frac{v^2}{2M^2}\right)+\frac{\lambda}{C}+1\right\}>0 \tag{5}$$

where μ^2 is substituted from eq.(3).The equation (5) is an extended form of Linde-Weinberg bound given by

$$\left\{\ln\left(\frac{v^2}{2M^2}\right)+1\right\}>0.$$

Thus we find that there is an additional term dependent on λ and C in eq.(5). The inclusion of λ-dependent term in the modified Linde-Weinberg bound is very interesting, because it may give ideas about λ. There is a relation between λ and C i.e. λ is dependent on one-loop effects given in C containing m^4_v , m^4_s and m^4_f. The value of λ is different at different energies but we consider it to be a constant at low energy (~100 Gev). For $\lambda=0$, eq.(4) gives

$$m_H^2=2v^2\,C\left[\ln\left(\frac{v^2}{2M^2}\right)+\frac{3}{2}\right] \tag{7}$$

so that we obtain

$$m_H^2>Cv^2 \tag{8}$$

For $m_s=0$, we obtain the values of C and m_H^2 .

The Higgs potential containing the two-loop correction term[7] to the full potential is

$$V=-\mu^2\phi^2+\lambda\phi^4+C\phi^4\ln\left(\frac{\phi^2}{M^2}\right)+\frac{3\lambda^3\phi^4}{56(16\pi^2)^2}(84l_\phi{}^2-176l_\phi-137) \tag{9}$$

where

$$l_\phi=\ln\left(\frac{\phi^2}{M^2}\right) \tag{10}$$

Using eq.(9), we calculate $\frac{\partial V}{\partial\phi}$ and the condition $\left.\frac{\partial V}{\partial\phi}\right|_{\phi=\frac{v}{\sqrt{2}}}=0$ to obtain

$$\mu^2=\lambda v^2+Cv^2\left\{\ln(\frac{v^2}{2M^2})+\frac{1}{2}\right\}+\frac{3\lambda^3v^2}{56(16\pi^2)^2}\left[84\left\{\ln\left(\frac{v^2}{2M^2}\right)\right\}^2-176\ln\left(\frac{v^2}{2M^2}\right)-137\right]+\frac{3\lambda^3v^2}{224(16\pi^2)^2}\left[336\ln\left(\frac{v^2}{2M^2}\right)-352\right] \tag{11}$$

Hence, with the inclusion of two-loop correction term the Higgs mass is given by

$$m_H^2=-\mu^2+3\lambda\,v^2+3Cv^2\ln\left(\frac{v^2}{2M^2}\right)+\frac{7}{2}Cv^2+\frac{9\lambda^3v^2}{56(16\pi^2)^2}\left[84\left\{\ln\left(\frac{v^2}{2M^2}\right)\right\}^2-176\ln\left(\frac{v^2}{2M^2}\right)-137\right]+\frac{21\lambda^3v^2}{224(16\pi^2)^2}\left[336\ln\left(\frac{v^2}{2M^2}\right)-352\right]+\frac{9\lambda^3v^2}{(16\pi^2)^2} \tag{12}$$

Substituting the value of λ^2 from eq. (11) in eq. (12), the expression for Higgs mass comes out to be

$$m_H^2=2\lambda v^2+Cv^2\left\{2\ln\left(\frac{v^2}{2M^2}\right)+3\right\}$$

$$+\frac{3\lambda^3 v^2}{28(16\pi^2)^2}\left[84\left\{\ln\left(\frac{v^2}{2M^2}\right)\right\}^2 - 176\ln\left(\frac{v^2}{2M^2}\right) - 137\right]$$

$$+\frac{9\lambda^3 v^2}{112(16\pi^2)^2}\left[336\ln\left(\frac{v^2}{2M^2}\right) - 352\right] + \frac{9\lambda^3 v^2}{112(16\pi^2)^2} \quad (13)$$

We know that, $V\left(\frac{v}{\sqrt{2}}\right) < V(0)$ and since $V(0) = 0$ we get

$$-\mu^2 + \frac{\lambda v^2}{2} + \frac{Cv^2}{2}\ln\left(\frac{v^2}{2M^2}\right) + \frac{3\lambda^3 v^2}{112(16\pi^2)^2}$$

$$\left[84\left\{\ln\left(\frac{v^2}{2M^2}\right)\right\}^2 - 176\ln\left(\frac{v^2}{2M^2}\right) - 137 < 0\right]$$

Substituting the value of μ^2 from eq.(11) in the above inequality we get,

$$\frac{\lambda v^2}{2} + \frac{Cv^2}{2}\ln\left(\frac{v^2}{2M^2}\right) + \frac{Cv^2}{2} + \frac{3\lambda^3 v^2}{112(16\pi^2)^2}$$

$$\left[84\left\{\ln\left(\frac{v^2}{2M^2}\right)\right\}^2 - 176\ln\left(\frac{v^2}{2M^2}\right) - 137\right]$$

$$+\frac{3\lambda^3 v^2}{224(16\pi^2)^2}\left[336\ln\left(\frac{v^2}{2M^2}\right) - 352\right] > 0 \quad (14)$$

Using eqs. (13) and (14) we ultimately get

$$m_H^2 > \frac{3\lambda v^2}{2} + \frac{Cv^2}{2}\left[3\ln\left(\frac{v^2}{2M^2}\right) + 5\right]$$

$$+\frac{9\lambda^3 v^2}{112(16\pi^2)^2}\left[82\left\{\ln\left(\frac{v^2}{2M^2}\right)\right\}^2 - 176\ln\left(\frac{v^2}{2M^2}\right) - 137\right]$$

$$+\frac{15\lambda^3 v^2}{224(16\pi^2)^2}\left[336\ln\left(\frac{v^2}{2M^2}\right) - 352\right] + \frac{9\lambda^3 v^2}{(16\pi^2)^2} \quad (15)$$

3. Theoy of Perturbative validity for one and two loops Higgs potentials

The purpose of this section is to prove the perturbative validity of both one and two-loop Higgs potentials, which includes the effects of scalar, vector and fermion loops. Here we obtain the expressions for $|\alpha l_\sigma|$ for one and two- loop Higgs potential separetely.We shall also give the numerical values of $|\alpha l_\sigma|$ for the bounds on λ given by $0.369 \le \lambda \le 0.613$[9]. This gives an illustration of a general method which would establish whether the indicated spontaneous breaking actually exists or not.

3.1 αl_σ for 1-loop

We start with

$$V(\phi_{cl}) = \lambda\phi_{cl}^4 + C\phi_{cl}^4 \ln(\phi_{cl}^2 / M^2) - \mu^2\phi_{cl}^2 \quad (16)$$

where $C = \frac{1}{16\pi^2 v^4}(\Sigma 3m_v^4 + m_s^4 - 4\Sigma m_f^4)$. Here the effect of vector, scalar and fermion loops are taken into account.

We can write equation (1) as

$$V(\phi_{cl}) = \lambda\phi_{cl}^4 S(\phi_{cl})$$

where

$$S(\phi_{cl}) = 1 - \frac{\mu^2}{\lambda\phi_{cl}^2} + \frac{C}{\lambda}\ln\left(\frac{\phi_{cl}^2}{M^2}\right) \quad (17)$$

Or,

$$S(\sigma) = 1 - \frac{\mu^2}{\lambda\sigma^2} + \frac{C}{\lambda}l_\sigma \quad (18)$$

Here $l_\sigma = \ln\left(\frac{\sigma}{M^2}\right)$, so that

$$\frac{dS(\sigma)}{dl_\sigma} = \frac{C}{\lambda} + \frac{\mu^2}{\lambda\sigma^2} \quad (19)$$

Since,

$$2S(\sigma) + \frac{dS(\sigma)}{dl_\sigma} = 0 \quad (20)$$

we get, by substituting the values of $S(\sigma)$ and $\frac{dS(\sigma)}{dl_\sigma}$ in equation (20), the following relation

$$\alpha l_\sigma = \frac{\lambda\mu^2}{32\pi^2 C\sigma^2} - \frac{\lambda}{32\pi^2} - \frac{\lambda^2}{16\pi^2 C} \quad (21)$$

The parameters required for numerical calculations in natural unit of αl_σ and the Higgs masses are as follows :

v = 246 GeV ; $0.369 \le \lambda \le 0.613$;

C = - 0.00570118; σ = 246 GeV ;

M = 180 GeV

Using the parameters given above we get $|\alpha l_\sigma|$ = 0.0748961 for λ = 0.369 and $|\alpha l_\sigma|$ = 0.2074224 for λ = 0.613, suggesting that the potential is perturbatively valid.

3.2 Calculation of αl_σ for 2-loop

The 2-loop potential is

$$V(\phi_{cl}) = -\mu^2\phi_{cl}^2 + \lambda\phi_{cl}^4 + C\phi_{cl}^4\phi$$

$$+\frac{3\lambda^3\phi_{cl}^4}{56(16\pi^2)^2}[841^2\phi - 1761\phi - 137] \quad (22)$$

where

$$C = \frac{1}{16\pi^2 v^4}(\Sigma 3m_v^4 + m_s^4 - 4\Sigma m_f^4) \qquad (23)$$

and

$$S(\phi_{cl}) = \frac{V(\phi_{cl})}{\lambda {\phi_{cl}}^4}$$

$$= 1 - \frac{\mu^2}{\lambda {\phi_{cl}}^2} + \frac{Cl_\phi}{\lambda} + \frac{3\lambda^2}{56(16\pi^2)^2}[841^2\phi - 1761\phi - 137] \qquad (24)$$

Hence

$$S(\sigma) = 1 - \frac{\mu^2}{\lambda\sigma^2} + \frac{Cl_\sigma}{\lambda}$$

$$+ \frac{3\lambda^2}{56(16\pi^2)^2}[841_\sigma^2 - 1761_\sigma - 137] \qquad (25)$$

so that

$$\frac{dS(\sigma)}{dl_\sigma} = \frac{C}{\lambda} + \frac{\mu^2}{\lambda\sigma^2} + \frac{3\lambda^2}{56(16\pi^2)^2}[1681_\sigma - 176] \qquad (26)$$

Now, equation (20) gives

$$9(\alpha l_\sigma)^2 + (\frac{32\pi^2 C}{\lambda^2} - \frac{69\alpha}{7})\alpha l_\sigma + 2 - \frac{\mu^2}{\lambda\sigma^2} + \frac{C}{\lambda} - (\frac{411}{28} + \frac{66}{7})\alpha^2 = 0 \qquad (27)$$

Writing $X = \alpha l_\sigma$, eq.(27) can be written as

$$AX^2 + BC + C' = 0 \qquad (28)$$

where $A = 9$; $B = \frac{32\pi^2 C}{\lambda^2} - 69\frac{\alpha}{7}$ and $C' = 2 - \frac{\mu^2}{\lambda\sigma^2} + \frac{C}{\lambda} - (\frac{411}{28} + \frac{66}{7})\alpha^2$

The solution to eq.(28) is

$$X = \frac{-B \pm \sqrt{B^2 - 4AC'}}{2A} \qquad (29)$$

the parameters given above we get $|\alpha l_\sigma| = 0.079$ for $\lambda = 0.369$ and $|\alpha l_\sigma| = 0.7406781$ for $\lambda = 0.613$, so that the potential is perturbatively valid.

Table 1. The variation of Higgs mass(in GeV) with Higgs self-coupling(λ) for different mass scales M (= 180, 220, 250 GeVs) are given.

Higgs self coupling constant (λ)	Higgs mass (m_H) in GeV					
	M = 180 GeV		M = 220 GeV		M = 250 GeV	
	1-loop m $_H$ (GeV)	2-loop m $_H$ (GeV)	1-loop m $_H$ (GeV)	2-loop m $_H$ (GeV)	1-loop m $_H$ (GeV)	2-loop m $_H$ (GeV)
0.369	153.665	153.656	154.147	154.139	154.453	154.446
0.380	156.175	156.165	156.649	156.640	156.950	156.942
0.392	158.645	158.634	159.111	159.102	159.408	159.399
0.405	161.077	161.065	161.536	161.526	161.829	161.819
0.417	163.473	163.461	163.926	163.915	164.214	164.204
0.429	165.834	165.821	166.281	166.269	166.564	166.554
0.441	168.162	168.148	168.603	168.590	168.882	168.871
0.453	170.459	170.444	170.893	170.879	171.169	171.157
0.465	172.724	172.708	173.153	173.139	173.426	173.413
0.477	174.961	174.944	175.384	175.369	175.653	175.639
0.489	177.169	177.151	177.587	177.571	177.853	177.838
0.500	179.350	179.331	179.763	179.746	180.026	180.010
0.513	181.505	181.485	181.913	181.895	182.173	182.156
0.525	183.635	183.613	184.038	184.018	184.294	184.277
0.537	185.740	185.714	186.139	186.118	186.392	186.374
0.549	187.822	187.797	188.216	188.194	188.467	188.447
0.561	189.880	189.855	190.270	190.247	190.518	190.498
0.573	191.917	191.890	192.303	192.278	192.548	192.527
0.585	193.932	193.904	194.314	194.288	194.557	194.534
0.597	195.927	195.897	196.305	196.278	196.545	196.521
0.609	197.901	197.870	198.276	198.247	198.514	198.488
0.613	198.510	198.421	198.818	198.712	199.261	199.132

4. Results and Discussions

For precise value of λ, one can obtain Higgs mass from eq.(13) and Higgs mass bounds from eq.(15). But, since we do not have the knowledge of precise value of λ, we consider the bounds on λ given by $0.369 \le \lambda \le 0.613$[9], for obtaining the Higgs mass bounds from eq.(13).

The values of parameters used in these analyses are : v = 246 GeV, m_t = 175 GeV, m_b = 5 GeV, M_W = 80 GeV, M_Z = 91 GeV , M = 180 , 220 and 250 GeVs and C = -0.00570118 for m_s = 0. Using the above values for the parameters in the equations for Higgs mass eq.(13) we obtain the following results on the bounds on Higgs mass given in table-1 for different values of M. The values of Higgs mass is nearly independent of M. Further more, the results of calculation of $|\alpha l_\sigma|$ for one and two- loop effective potentials are given above in the sections 3.1 and 3.2 ,where we observe that $|\alpha l_\sigma| < 1$ for all the cases considered here. So, the predictions on the Higgs masses are perturbatively valid. We also find that the effect of two-loop contribution is negligibly small.

4. Conclusions

On the basis of the above studies we are led to the following conclusions : (i) The minimum value of Higgs mass is far above the LEP2 bounds so that only LHC experiments can prove the possibility of higher values of the Higgs mass obtained in the range 153 GeV $\le m_H \le$ 200 GeV .(ii) These studies extend the previous studies by giving more complete and systematic studies on the Higgs mass bounds for a current bound on λ. (iii)These results will help the LHC experimentalists in selecting the appropriate range of energy for the purpose of detection of the Higgs boson.(iv) The two-loop correction term does not affect the results obtained from one-loop calculation.(v) The calculation of Higgs mass has been linked with perturbative validity for correct calculation of Higgs mass as shown in the work of Miller[7] and in this way the choice of λ is restricted such that $|\alpha l_\sigma| < 1$.

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