Mass Spectrum of the Higgs Boson 125 GeV

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Abstract: Within the Everlasting Theory I described mass spectrum of the Higgs boson 125.00 GeV. Due to the quadrupole symmetry characteristic for the weak interactions and due to the interactions of the Higgs-boson pairs with the dominant gluon balls 3.30 GeV, there appear two masses $M_1 = 126.65 \pm 0.31$ GeV and $M_2 = 123.35 \pm 0.31$ GeV. The Higgs-boson pairs can decay into 4 photons or 4 leptons but into two Z-bosons as well. Due to the same symmetry, the Higgs boson should decay into two photons twice as often as it should.

1. Introduction and calculations

The internal structure of the core of baryons and the confinement (the confinement follows from the weak interactions) of the Einstein spacetime components produced by electromagnetic energy, lead to the mass of the Higgs boson 125.00 GeV [1] (see Chapter "Electroweak Interactions, Non-Abelian Gauge Theories and Origin of $E = mc^2$"). On the other hand, from the formulae (214)-(216) derived within the reformulated QCD [1] (see Chapter "Reformulated Quantum Chromodynamics") follows that there is an amplification for the energy of gluon balls equal to 3.304 GeV. Just such gluon balls produce identical gluon balls. Such gluon ball I will refer to as the amplifier. The unified formula of the formulae (214)-(216) is as follows

$$M[GeV] = (C/E_N[GeV] + D)^{10}, \qquad (1)$$

C = 0.52294,
D = 0.96868,
E_N is the energy of collision per nucleon,
M is the energy of produced gluon ball.

Due to the internal structure of the cores of baryons (there is torus and ball in its centre composed of the Einstein spacetime components) there is valid the quadrupole symmetry for the weak interactions [1] (see Chapter "Neutrino Speed"). This means that we should observe the decays into 4 leptons or 4 photons but such decays should be characteristic for Higgs-boson pairs, not for single Higgs bosons. The Higgs-boson pairs can decay into two Z bosons as well. The decays of the Higgs-boson pairs into 4 photons cause that the decays into two photons are twice as often as it should.

But the components of a Higgs-boson pair cannot be in the same state. Because there dominate the amplifiers 3.304 GeV, so such mass can be absorbed by one of the two components and then the mean central mass of the components in a Higgs-boson pair is 126.65 GeV. But some amplifier can force emission of amplifier by one of the two components of a Higgs-boson pair. Then the mean central mass is 123.35 GeV. It looks as a Gluon Amplification by Stimulated Emission (the GASE). There is a broadening of mass of the amplifier 3.304 GeV which follows from the decays inside the baryons [1] (see the description below the formulae (214)-(216)). The upper limit for the broadened mass we obtain multiplying the mass 3.304 GeV by $2^{1/4} = 1.1892$ so we obtain 3.929 GeV. This means that we can write the broadened mass as follows: 3.304 ± 0.313 [GeV]. The two modified mean masses of the Higgs bosons detected in the LHC experiments should be as follows

$M_1 = 126.654 \pm 0.313$ GeV and $M_2 = 123.350 \pm 0.313$ GeV.

It is consistent with experimental data [2].

We can see that the real mass of the Higgs boson is indeed 125.00 GeV because the observed mass distance 3.304 GeV is due to the interactions of the Higgs-boson pairs with the amplifiers.

Analyse thoroughly the equation (1). For $E_N \rightarrow \infty$ the energy of the gluon ball M is 727.44 MeV. It is the mass of the core of baryons [1]. Since energy of gluon ball M decreases when energy of collision per nucleon E_N increases (the energy E_N I will refer to as the gluon propagator) then we can assume that at low energy of gluon propagator, there arise the virtual gluon-ball pairs carrying the energy ±727.44 MeV = 0 as well. On the other hand, the equation (1) has physical sense also for negative energy of gluon propagator. This follows from the fact that negative energy of gluon propagator or gluon ball means the creation of an energy depression in the strong field. We can see that the energy of gluon ball(s) is equal to zero for energy of virtual gluon propagator equal to –539.9 MeV, i.e. for the rest energy of four confined virtual neutral pions $E_N = -4m_{pion(o)}$. Due to the quadrupole symmetry for the weak interactions [1] that follows from the internal structure of the core of baryons, there can appear objects containing four confined neutral pions. At low energy there appear mostly the virtual pairs carrying energy ±539.9 MeV = 0. The negative propagator carrying energy –539.9 MeV creates the virtual gluon-ball pairs carrying energy ±727.44 MeV = 0. We can see that due to the equation (1), which follows from the internal structure of the core of baryons [1], there is broken symmetry between the behaviour of the virtual negative and positive propagators. The negative propagator (energy = –539.9 MeV) leads to resultant energy of virtual gluon pair (±727.44 MeV) equal to zero whereas the positive (energy = +539.9 MeV) to energy of single gluon-ball equal to 745 GeV. Such gluon ball cannot be created at low energy.

The above analysis is consistent with results presented here [3]. The conclusion is that the infrared data can be associated with a massive propagator up to momenta in approximation 500 MeV. There appears a constant gluon mass of 723(11) MeV. We obtain such result when we exclude the zero-momentum gluon propagator from the analysis. We can see that the formula (1) has no physical sense for zero-momentum gluon propagator as well.

The all gluon balls have the same mass Y = 424.1 MeV [1] but due to the rotating-spin of the carriers of gluons the gluon balls consist of, the gluon balls can have different energies. From it follows that the coupling constant of weak interactions of all gluon balls is the same. They all are the black holes in respect of the weak interactions [1]. Due to the random orientations of the spins of the carriers of gluons a gluon-ball consists of, the gluon-balls are the scalars. In the nature the pairing is widespread. This follows from the fact that binary systems have additional angular momentum and in interactions this angular momentum can change if it is necessary. But the components in a pair must be in different state, for example, in different mass state. The energetic gluon balls appear as the gluon-ball pairs, for example, probability of creation of Higgs-boson pairs is much higher than of single Higgs bosons. The gluon balls can transform into loops and then into tori [1]. The mean distance between the carriers of gluons in a gluon ball is a little shorter than in the Einstein spacetime [1]. This means that absorption of a gluon ball by some other gluon ball leads to decay into photons whereas an emission causes that the confinement is still valid so the gluon balls decay into leptons. Due to the quadrupole symmetry for the weak interactions [1], there appear 4 photons (the γγγγ) or 4 leptons (the llll). The gluon-ball pairs can decay into two Z bosons as well (the ZZ). From the formula (1) follows that there is higher number density of the gluon balls carrying energy 3.30 GeV (the G_o). This causes that the decays of the Higgs bosons into 4 photons lead to the mean central mass 126.65 GeV, the decays into 4 leptons lead to the mean central mass 123.35 GeV whereas into 2 Z bosons, and next into 4 leptons, to 125.00 GeV. Some summary for the selected Higgs boson pairs (the HH) decays is as follows.

HH + G_o → γγγγ : the mean mass of H is 126.65 ± 0.31 GeV,
HH – G_o → llll : the mean mass of H is 123.35 ± 0.31 GeV,
HH ± G_o → ZZ → llll : the mean mass of H is 125.00 GeV.

In the two last channels of decays appear the 4 leptons so we should observe a combined mass that depends on intensities of the different modes of decays. The same concerns the combined best-fit mass of the Higgs boson. But we can see that the observed differences in mass of the Higgs boson follow from its interactions. The real mass of the Higgs boson is 125.00 GeV. We can compare these theoretical results with experimental results observed with the ATLAS Detector at the LHC [2], [4] and the CMS Experiment at the LHC [5].

Due to the confinement [1] and the spin-rotation of the carriers of gluons, but of photons as well, the energy of the gluon balls can accumulate. We can see that the sum of the masses of the characteristic mass of gluon propagator 539.9 MeV and the constant gluon mass 727.44 MeV, is in approximation 1267 MeV. It is the mass of the charm quark. When in the equation (1) we use the mass of the charm quark 1.267 GeV as the energy M of gluon ball then we obtain for the gluon propagator energy in approximation E_N = 9.460 GeV. This energy is the mass of the boson Υ(1S, 9460 MeV). There, as well, appear masses of other known particles [1]. This follows from the atom-like structure of baryons.

The core of the baryons consists of the torus and ball in its centre [1]. The torus is the strong/electric charge. For distances shorter than about 3 fm the torus behaves as the strong charge whereas for distances longer than about 3 fm the torus behaves as the electric charge [1].

3. Summary

Within the Everlasting Theory I described mass spectrum of the Higgs boson 125.00 GeV. Due to the quadrupole symmetry characteristic for the weak interactions and due to the interactions of the Higgs-boson pairs with the dominant gluon balls carrying mass 3.30 GeV, there appear two different masses M_1 = 126.65 ± 0.31 GeV and M_2 = 123.35 ± 0.31 GeV. But the real mass of the Higgs boson is 125.00 GeV. The Higgs-boson pairs can decay into 4 photons or 4 leptons but into two Z-bosons as well.

Due to the quadrupole symmetry, the Higgs bosons decays into two photons twice as often as it should.

At the low energy of interacting nucleons there appears constant gluon energy equal to 727.44 MeV and asymmetry in interactions of negative and positive virtual gluon propagators. Due to confinement of gluon balls and gluon propagators there can appear mass of the charm quark. Due to the atom-like structure of baryons there can appear the other masses of quarks as well [1].

References

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