# Lifetimes of Higgs, W and Z Bosons in the Scale-Symmetric Physics

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**Abstract:** Here, within the Scale-Symmetric Physics, we calculated the rigorous lifetimes of Higgs (H) boson, W and Z bosons expressed in yoctoseconds [ys] (yocto is the inverse of the 24 powers of ten): for H is 0.282 ys, for W is 0.438 ys whereas for Z is 0.386 ys. They are the upper limits for experimental data and it is obvious that the experimental data should be close to such limits. The decay width of H boson (about 3.4 GeV/(cc) gives 0.194 ys, the decay width of W boson (about 2.1 GeV/(cc) gives 0.316 ys whereas the decay width of Z boson (about 2.5 GeV/(cc) gives 0.264 ys. The calculated here theoretical results are consistent with experimental data. The lifetime of Higgs boson predicted within the Standard Model (SM), 0.156 zeptoseconds [zs] (zepto is the inverse of the 21 powers of ten), is inconsistent with experimental data - it suggests that SM is at least incomplete or partially incorrect. The main method to determine the lifetimes of particles follows from measurement of the decay width. But using this widely accepted method, we obtain the lifetime of the Higgs boson a factor of one thousandth of the value predicted by the Standard Model. It causes that some “scientists” try to change the widely accepted method to obtain from the experimental data the SM value. As usually, when a mainstream theory fails, to fit theoretical results to experimental data, “scientists” apply some approximations, mathematical tricks and free parameters. The truth is obvious - the experimental lifetime of the sham Higgs boson with a mass of 125 GeV is inconsistent with the SM prediction. Photons inside strong fields behave as gluons.

## 1. Introduction

The succeeding phase transitions of the Higgs field and the symmetrical decays of bosons, which lead to the atom-like structure of baryons, are the foundations of the Scale-Symmetric Physics (S-SP) [1].

Within S-SP, we described internal structure of the detected composite sham Higgs boson with a mass of 125 GeV, we calculated its mass, solved the hierarchy problem, calculated branching ratios, showed why its mass is very messy, calculated masses of next composite sham Higgs bosons, described the real Higgs mechanism, quantum entanglement and confinement, and we calculated the coupling constant responsible for interactions of the constituents of the composite sham Higgs boson – the References are listed here [2].

Here, applying the S-SP we calculated the rigorous lifetimes of Higgs, W and Z bosons.

**2. Calculations**

According to S-SP, the composite sham Higgs boson (the H; spin = 0) and the W and Z bosons (spin = 1) are the condensates composed of the confined Einstein-spacetime components (the W and Z bosons rotate). The luminal Einstein-spacetime components are the still undetected neutrino-antineutrino pairs. They are the carriers of gluons and photons which are their rotational energies. The different properties of the gluons and photons do not follow from different structure of the carriers (their properties are the same and they have the three internal helicities/colors) but due to their internal helicities they behave differently in fields having internal helicity (the strong fields have internal helicity so there are 8 different gluons [1]) and in fields without internal helicity (the electromagnetic fields do not have internal helicity so there is 1 photon). We can see that photons interacting with nucleons interact strongly i.e. the photons inside the strong fields behave as gluons.

The coupling constant defining the interactions/confinement of the constituents of the composite H is very small [2] so the condensates are very unstable. The condensates, as a whole, decay due to the weak interactions characteristic for baryons. The coupling constant for the weak interactions of baryons is $\alpha_{W(proton)} = 0.0187229 \approx 1 / 53.41$ ([1]: formula (51)). The H, W and Z bosons decay due to their weak mass, $M_{Weak}$,

$$M_{Weak} = \alpha_{W(proton)} M = \Gamma / c^2, \tag{1}$$

where $M$ is the mass of a condensate whereas the ($M_{Weak}$ $c^2$) is the decay width $\Gamma$.

On the other hand, lifetime of a condensate is defined as follows

$$\tau = \hbar / \Gamma = \hbar / (M_{Weak} c^2) = \hbar / (\alpha_{W(proton)} M c^2). \tag{2}$$

Applying formula (2) we obtain the rigorous theoretical lifetimes – they are the upper limits for experimental data. It follows from the fact that theoretical decay width always has higher accuracy than experimental ones (it is due to the systematic and statistical errors)

$$\Gamma_{H,theory(S\text{-}SP)} \approx 2.34 \text{ GeV} / c^2 \rightarrow \tau_{H,theory} = 2.82 \cdot 10^{-25} \text{ s}, \tag{3a}$$

$$\Gamma_{W,theory(S\text{-}SP)} \approx 1.51 \text{ GeV} / c^2 \rightarrow \tau_{W,theory} = 4.38 \cdot 10^{-25} \text{ s}, \tag{3b}$$

$$\Gamma_{Z,theory(S\text{-}SP)} \approx 1.71 \text{ GeV} / c^2 \rightarrow \tau_{Z,theory} = 3.86 \cdot 10^{-25} \text{ s}. \tag{3c}$$

Applying formula (2) and knowing the decay widths, [3], we obtain the experimental lifetimes

$$\Gamma_{H,exp.} \approx 3.4 \text{ GeV} / c^2 \rightarrow \tau_{H,exp.} = 1.94 \cdot 10^{-25} \text{ s}, \tag{4a}$$

$$\Gamma_{W,exp.} \approx 2.1 \text{ GeV} / c^2 \rightarrow \tau_{W,exp.} = 3.16 \cdot 10^{-25} \text{ s}, \tag{4b}$$

$$\Gamma_{Z,exp.} \approx 2.5 \text{ GeV} / c^2 \rightarrow \tau_{Z,exp.} = 2.64 \cdot 10^{-25} \text{ s}. \tag{4c}$$

We can see that calculated here theoretical results are consistent with experimental data. The lifetime of Higgs boson predicted within the Standard Model (SM) is inconsistent with experimental data - it suggests that SM is at least incomplete or partially incorrect

$$\tau_{H,theory(SM)} = 1.56\cdot10^{-22}\ s. \quad (5)$$

The main method to determine the lifetimes of particles follows from measurement of the decay width. But using this widely accepted method, we obtain the lifetime of the Higgs boson a factor of one thousandth of the value predicted by the Standard Model. It causes that some “scientists” try to change the widely accepted method to obtain from the experimental data the SM value. As usually, when a mainstream theory fails, to fit theoretical results to experimental data “scientists” apply some approximations, mathematical tricks and free parameters. The truth is obvious - the experimental lifetime of the sham Higgs boson with a mass of 125 GeV is inconsistent with the SM prediction.

Notice as well that

$$\tau_{theory} / \tau_{exp.} = \Gamma_{exp.} / \Gamma_{theory} = sqrt(2). \quad (6)$$

It suggests that the energy responsible for decay, $\Gamma_{theory}$, appears on the Schwarzschild surface for the strong interactions [1]. Then, its relativistic mass is $\Gamma_{exp.} = \Gamma_{theory}$ sqrt(2), [1], and it leads to the perfect consistency of the Scale-Symmetric Physics with experimental data concerning the lifetimes of H, W and Z bosons.

The lifetimes of the Type composite-Higgs bosons can be calculated using a different method. At first, before the main decay, the spinless condensates swell in such a way that there appears a condensate composed of the condensates which are in centre of the baryons each with a mass of Y = 424.12 MeV, [1], – it is the reason that in formula (2) appears $\alpha_{W(proton)}$. Condensates with such a mass are the black holes in respect of the weak interactions i.e. on their surfaces the neutrino-antineutrino pairs have the luminal spin speed on the orbits with radius equal to the equatorial radius [1] – it is the reason that there appears the intermediate stage in the decays. The equatorial radius of Y is $r = 0.8710945\cdot10^{-17}$ m ([1]: formula (49)) so the characteristic length is $2\pi r$. Before the main decay, all the Type composite-Higgs condensates transform into the associations composed of the masses Y so they all should have similar lifetimes close to

$$\tau_{H,theory,new\text{-}method} = 2\pi r / c \approx 1.83\cdot10^{-25}\ s. \quad (7)$$

This value is very close to the experimental lifetime of the composite Higgs boson with a mass of 125 GeV ($\tau_{H,exp.} = 1.94\cdot10^{-25}$ s).

There should be at least two additional such condensates with a mass of about 321 GeV and 17.1 TeV [4] but no one is the real Higgs boson. The first signal can be partially suppressed by the two observed peaks one at 125 GeV (it is the discovered composite Higgs) and by the broadened peak at about 200 GeV (see Fig. in cited paper) – the sum 125 + 200 is close to the 321 GeV.

There is in existence the non-gravitating field (i.e. the Higgs field) which during the inflation partially transformed into the gravitating luminal Einstein spacetime. According to the S-SP, the Einstein spacetime is grainy and consists of the still undetected gravitating neutrino-antineutrino pairs. The real Higgs mechanism described within S-SP shows how the non-gravitating field transformed into the smallest gravitational masses i.e. the neutrinos. The S-SP shows as well that the tremendous non-gravitating energy frozen inside a neutrino (it cannot be observed directly) is about 119 powers of ten (precisely, $0.6\cdot10^{119}$) greater than the gravitational mass of the neutrino – it is the lacking energy predicted by the mainstream quantum physics [1].

In reality, the Planck mass/energy does not concern a gravitational mass. The Planck mass/energy concerns the luminal/superluminal limit of Nature. Just the geometric mean of the tremendous non-gravitating energy frozen inside a neutrino and its gravitational mass is close to the Planck mass. The real Higgs boson must be a spinless particle so the real Higgs boson consists of two confined and entangled neutrino-antineutrino pairs. Its gravitational mass is very small and beyond precision of the present-day detectors but the not observed directly energy frozen in the real Higgs boson is tremendous. It solves the Hierarchy Problem.

The discovered composite Higgs boson with a mass of 125 GeV consists of the confined real Higgs bosons with very low gravitational mass but with tremendous non-gravitating energy frozen inside them.

There appeared papers with mathematical tricks to fit the experimental width of the Higgs boson with a mass of 125 GeV (about 3.4 GeV [5]) to the Standard Model value (the width should be about 800 times lower (!)). On the CERN public website (30 March 2014), [5], we can read as follows: "The best bound one could obtain directly from the Higgs peak in the data was that the width was less than 3.4 GeV."

There was a suggestion that we can calculate the Higgs width from the mass distribution of it at much higher energy than 125 GeV. A quantitative analysis leads to decay width approximately 17 MeV [5]. The error is obvious. It is the decay width of a condensate with a mass of nucleon ($M_{Nucleon} \approx 939$ MeV). Its decay width is

$$\Gamma_{Condensate,nucleon(S\text{-}SP)} = M_{Nucleon}\, \alpha_{W(proton)} = 17.58 \text{ MeV}. \qquad (8)$$

It leads to the lifetime of such condensate

$$\tau_{Condensate,nucleon(S\text{-}SP)} = \hbar / \Gamma_{Condensate,nucleon(S\text{-}SP)} = 0.3744 \cdot 10^{-22} \text{ s}. \qquad (9)$$

It is about 4.17 times shorter lifetime than the SM lifetime of the SM Higgs boson (see formula (5)).

Here we proved that the width about 3.4 GeV is correct and that the papers containing the mathematical tricks to decrease the experimental decay width of the detected composite Higgs boson are incorrect.

**References**

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