The Illusory Total Width of the Off-Shell Higgs Bosons

Sylwester Kornowski

Abstract: Within the Scale-Symmetric Theory (SST) we show that the transition from the nuclear strong interactions in the off-shell Higgs boson production to the nuclear weak interactions causes that the real total width of the Higgs boson from the Higgs line shape (i.e. 3.3 GeV) decreases to 4.3 MeV that is the illusory total width. Moreover, there appear some glueballs/condensates with the energy 3.3 GeV that accompany the production of the off-shell Higgs bosons.

1. Introduction

In Table 1, we present the ATLAS and CMS results for upper limits of the total width (in GeV) of the Higgs boson from the Higgs line shape (mass spectrum) in the H → γγ channel 1 and H → ZZ* → 4*l* channel 2 at 95% CL limit [1].

Table 1 *Upper limits of the total width of H from line-shape* [1]

	Channel 1	**Channel 2**
ATLAS	< 5.0 (6.2)	< 2.6 (6.2)
CMS	<2.4 (3.1)	<1.1 (1.6)

On the other hand, the measured total width of the off-shell Higgs bosons is [2]

$$\Gamma_{\text{H,off-shell}} = 4.6^{+2.6}_{-2.5}\ \mathbf{MeV}\,. \tag{1}$$

Why are the total width obtained from the mass spectrum (the upper limits) and the total width of the off-shell Higgs bosons so different, about three orders of magnitude?!

In this paper, using the Scale-Symmetric Theory (SST) [3], we are trying to answer this important question.

We will use the two equations we obtained in SST.

2. The first equation and the full width of the spacetime condensates

The first formula is for the total width of the spacetime condensates (due to their weak interactions that dominate) such as the Higgs boson H, $W^{\pm}$ bosons or Z bosons

$$\Gamma_{\text{weak}} = 2^{1/2}\,\alpha_{w(p)}\,M\,, \quad . \tag{2}$$

where $\alpha_{w(p)} = 0.0187229$ is the SST coupling constant for the nuclear weak interactions [3].

From (2), for the $W^{\pm}$ bosons we obtain $\Gamma_{weak,W\pm} = 2.1$ **GeV** (the experimental value is ~2.1 **GeV** [1]), for Z bosons is $\Gamma_{weak,Z} = 2.4$ **GeV** (the experimental value is ~2.5 **GeV** [1]), and for the Higgs boson we obtain $\Gamma_{weak,H} = 3.3$ **GeV** (it is consistent with the line-shape total width but it is inconsistent with the value for the off-shell Higgs bosons).

The consistency of the SST theoretical results and experimental results for $W^{\pm}$ bosons and Z bosons suggests that there is no reason to say that the SST result for the Higgs boson is wrong.

What is the origin of formula (2)?

For the spacetime-condensate resonances, their cross sections as function of energy have the approximate form of a Breit-Wigner line shape (see Fig.1).

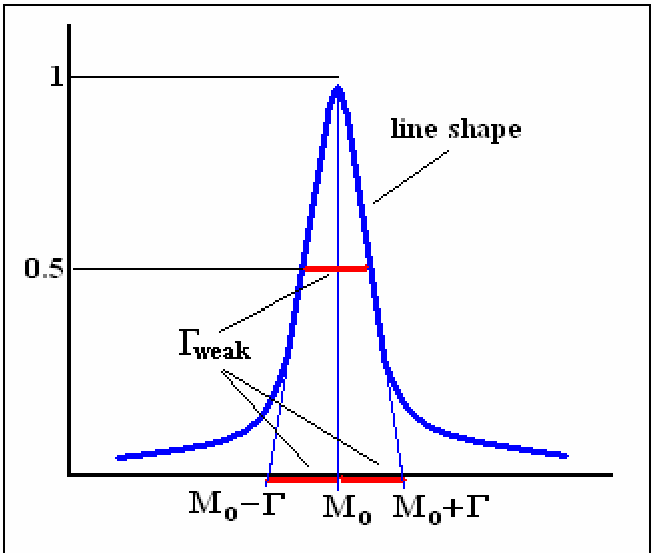

Fig.1 Breit-Wigner line shape.

According to SST, the spacetime condensates with masses equal or higher than Y = 424.12 **MeV** are the black holes for the nuclear weak interactions [3]. Scalar Higgs bosons and the vector $W^{\pm}$ and Z bosons are such condensates. Orbital speed of virtual particles created on the Schwarzschild surface for the nuclear weak interactions that are the weak masses is c/2, so their relativistic absolute masses are $2^{1/2}$ times higher than their rest masses. Such virtual particles on the Schwarzschild surface can be emitted or absorbed by the spacetime condensates and their mean absolute mass is defined by formula (2). Such is the origin in SST of the full width of the SST spacetime condensates.

3. The second formula

The second formula relates the mass of the created glueballs composed of the SST fundamental gluon loops (FGLs) that are responsible for the nuclear strong interactions (i.e. there are loops) or the masses of the quarks/loops with the scalar or vector spacetime condensates and other particles. The original formula looks as follows [3]

$$M_{Glueball,Loop}\,[GeV] = a_q\,(b_q / m_{Condensate,Particle}\,[MeV] + A\,[fm])^{10}\,, \qquad (3)$$

where $a_q = 26.71238$ **GeV/fm**^{10}, $b_q = 376.5249$ **fm·MeV**, and $A = 0.6974425$ **fm** is the equatorial radius of the core of baryons.

We can rewrite formula (3) as follows

$$M_{G,L}\,[\mathrm{GeV}] = (C / m_{C,P}\,[\mathrm{GeV}] + D)^{10}\,, \tag{4}$$

where $C = 0.52296$, and $D = 0.96868$.

For example, from (4), for $m_{\mathrm{Particle}} \equiv \Upsilon(9.460$ **GeV**$)$, we obtain mass of the **c-quark** = 1.267 **GeV**, and so on (see [3]).

In formula (4), there is the radius with the exponent 10 because within SST we show that the loops and the glueballs composed of loops have 10 degrees of freedom.

4. Why the Standard Model mimics the Scale-Symmetric Theory at higher energies?

We must answer this question to understand the problem.

SST shows that the electron consists of the real charged bare electron and only one the virtual bare electron-positron pair [3], i.e. the positive mass of the virtual pair is two times higher than the mass of the real bare electron. On the other hand, in nucleons is the real spin-1/2 charge $X^+ = 318.3$ **MeV** that is the source of the nuclear strong interactions and electromagnetic interactions, so by an analogy to the electron, there should be only one virtual X^+X^- pair with the positive mass $2 \cdot 318.3$ **MeV**. It means that in such a system we have three charged spin-1/2 parts (two fermions and one antifermion) each with mass ~318 **MeV** as it is in the quark model of nucleons (each quark has relativistic mass about 300 **MeV**). In SST, we showed also that the fractional electric charges of quarks ($+2e/3$ and $-1e/3$), for a sample containing 50% protons and 50% neutrons, mimic the elementary charges of the SST nucleon components [3].

Moreover, the rest masses of the u-quark and d-quark are associated with the mass distances between both the charged and neutral core of baryons and between the relativistic pions in the d=1 state.

SST shows that in the high-energy particle physics, most important are the peripheral processes concerning the last d=4 orbit for the nuclear strong interactions and the dynamics of the core of baryons. The last orbit is associated with the production of the b-quarks (~4190 **MeV**) and with **the virtual field composed of the relativistic charged pions with a mass of 162 MeV** [3]. On the other hand, from formula (4) follows that the sum of masses of the two main parts of the baryonic core (742.42 **MeV**) leads to mass of the t-quark (~172 **GeV**).

It leads to a conclusion that the high-energy particle physics should be based on the quark-antiquark pairs of the two heaviest quarks (b and t) and on the virtual field composed of the 162-MeV relativistic pions, but emphasize that such peripheral virtual field is very important also at low energies!

Emphasize also that neutrinos acquire their masses due to interactions with the SST Higgs field. It is not true that the Higgs boson relates directly to the SST Higgs field. The Higgs boson acquires its mass due to the confinement of the SST absolute-spacetime components – such interaction is not the fundamental interaction between the SST Higgs field and the components of the neutrinos.

SST shows that, unlike the SST Higgs field, Nature works fine without the Higgs boson, so there is no point in defending its Standard-Model properties at all costs.

Within SST we already calculated mass of the Higgs boson [3]

$$m_{H,SST} = 125.006 \ \mathbf{GeV} \ . \tag{5}$$

Now the value of the Higgs mass from ATLAS is [4]

$$m_{H,ATLAS} = 124.99 \pm 0.18 \ (\text{stat}) \pm 0.04 \ (\text{syst}) \ \mathbf{GeV} \ , \tag{6}$$

so the central value, i.e. 124.99 **GeV**, is much closer to the SST value.

But we can calculate also the second SST value for the Higgs boson. Assume that a mean nucleon $(p+n)/2 = 938.919$ **MeV** emits the mean positive mass of virtual pion $(\pi^{\pm}+\pi^{o})/2 = 137.274$ **MeV**, so mass of nucleon decreases to $M = 0.80165$ **GeV**. Next such mass collapses to a scalar spacetime condensate. Then, applying formula (4) for the mass 0.80165 **GeV**, we obtain the "second Higgs mass" equal to

$$m_{H,SST,2} = 125.29 \ \mathbf{GeV} \ . \tag{7}$$

This value is consistent with the PDG value 125.25(17) **GeV** [1]. **Notice that from formula (4) results that it is not mass of the scalar spacetime condensate (Higgs boson) but the mass of the scalar glueball!**

5. Calculations

Notice that formula (4) is obligatory for following relationship (it is a resonance)

$$M_{Glueball} \ [\text{GeV}] = m_{Condensate} \ [\text{GeV}] = 3.3 \ \mathbf{GeV} \ , \tag{8}$$

i.e. is obligatory for the SST real total width of the Higgs bosons. It can additionally lead to wrong results for the off-shell Higgs bosons.

We know that the gluon fusion production process is the dominant production mode. For the $ZZ \rightarrow 4l$ and $ZZ \rightarrow 2l2\nu$ channels, there initially appear the glueballs that only then transform into the scalar spacetime condensates – see the collapse of the fundamental gluon loops (FGLs) described in [3], the gluon-gluon fusion (ggF) Higgs boson production is due to the nuclear strong interactions of the FGL pairs, so for the coupling constant we have [3]

$$\alpha_s^{pp,\pi} = 14.391187 \ . \tag{9}$$

Such glueballs, due to the nuclear weak interactions, can transform into the scalar spacetime condensates, so we have [3]

$$\alpha_{w(p)} = 0.0187229 \ . \tag{10}$$

The ratio of the strong coupling constant to the weak coupling constant is

$$f = \alpha_s^{pp,\pi} / \alpha_{w(p)} = 768.641 \ , \tag{11}$$

and such number of times decrease both the real total width of the Higgs boson calculated within SST and the mass of the of-shell Higgs bosons

$$\Gamma_{\text{weak,H,illusory}} = \Gamma_{\text{weak,H}} / f = 3.3\ \mathbf{GeV} / 768.641 = 4.3\ \mathbf{MeV}, \tag{12}$$

$$M_{\text{H,new}} = m_{\text{H,SST}} / f = 125.006\ \mathbf{GeV} / 768.641 = 162.6\ \mathbf{MeV}. \tag{13}$$

The last mass is close to mass of the virtual relativistic pions in the peripheral dominating virtual field in baryons [3], so we have a resonance.

But emphasize that we cannot apply formula (2) to the mass 162.6 MeV because it is lower than Y, so it cannot be a spacetime-condensate black hole for the nuclear weak interactions.

Such is the origin of the "total width" of the off-shell Higgs bosons.

Consider the "total width" of the Z boson for the off-shell measurements. From (11)-(13) we obtain

$$\Gamma_{\text{weak,Z,illusory}} = \Gamma_{\text{weak,Z}} / f = 2.4\ \mathbf{GeV} / 768.641 = 3.1\ \mathbf{MeV}, \tag{14}$$

$$M_{\text{Z,new}} = m_{\text{Z,SST}} / f = 91.1894\ \mathbf{GeV} / 768.641 = 118.6\ \mathbf{MeV}. \tag{15}$$

We can see that contrary to the 4.3 **MeV** for the Higgs boson, the 3.1 **MeV** signal for the Z boson should be much less clear because of lack of a resonance. Notice also that the 3.1 **MeV** is very close to the central value of the PDG result $\Gamma = 3.2^{+2.4}_{-1.7}$ **MeV** on the assumption that the on-shell and off-shell effective couplings are the same [1].

The CMS-Collaboration team obtained $\Gamma_H = 3.2^{+2.4}_{-1.7}$ **MeV** (at 95% CL.) using 140 fb^{-1} $4l$ on-shell plus 78 fb^{-1} $4l$ off-shell plus 138 fb^{-1} $2l2\nu$ off-shell [5] so the CMS central value (3.2 **MeV**) is very close to our value (3.1 **MeV**).

For ZZ→ $2l2\nu$, the CMS team obtained $\Gamma_H = 3.1^{+3.4}_{-2.1}$ **MeV** at 68% CL [5]. The $2l2\nu$ analysis was based on the reconstruction of Z→ ll decays with a second Z boson decaying to neutrinos that escaped detection.

Probably the differences in the ATLAS and CMS measurements were the cause of the different central values (i.e. 4.6 **MeV** and 3.2 **MeV**, respectively). Just in ATLAS dominated the production of the Higgs bosons while in CMS dominated the production of the Z bosons.

6. The off-shell Higgs bosons production and detection

The Higgs bosons can be produced outside the peak 125 **GeV**, i.e. off-shell.

In the ATLAS experiment [2], there was an attempt to measure the total width of the Higgs boson in the off-shell production. Via formula (12) we showed that it is untrue. The correct description of the Higgs boson production and detection is graphically presented in Fig.2 and Fig.3.

According to SST, the core of protons is internally left-handed so it produces the fundamental gluon loops (FGLs) with the left-handed internal helicity. On the other hand, the neutral pion consists of two FGLs, so the virtual neutral pion in the final state carries the internal helicities of the initial gluons which in the gluon-gluon fusion create the scalar-Higgs and vector-Z bosons. Just the internal helicity must be conserved. Coupling constant for such virtual neutral pion is $\alpha_s^{pp,\pi} = 14.391187$ [3]. On the other hand, the four leptons in the final state interact electroweakly: $\alpha_{em} = 1 / 137.035999$ is the fine structure constant while $\alpha_{w(e)} = 0.951118 \cdot 10^{-6}$ is the coupling constant for the weak interactions of the charged leptons [3]. The virtual neutral pion and the four leptons in the final state are entangled but their interactions are not simultaneous, so there appears the product of the three above coupling constants. According to SST, the Higgs boson and the Z and $W^{\pm}$ bosons interact due to the nuclear weak interactions ($\alpha_{w(p)} = 0.0187229$).

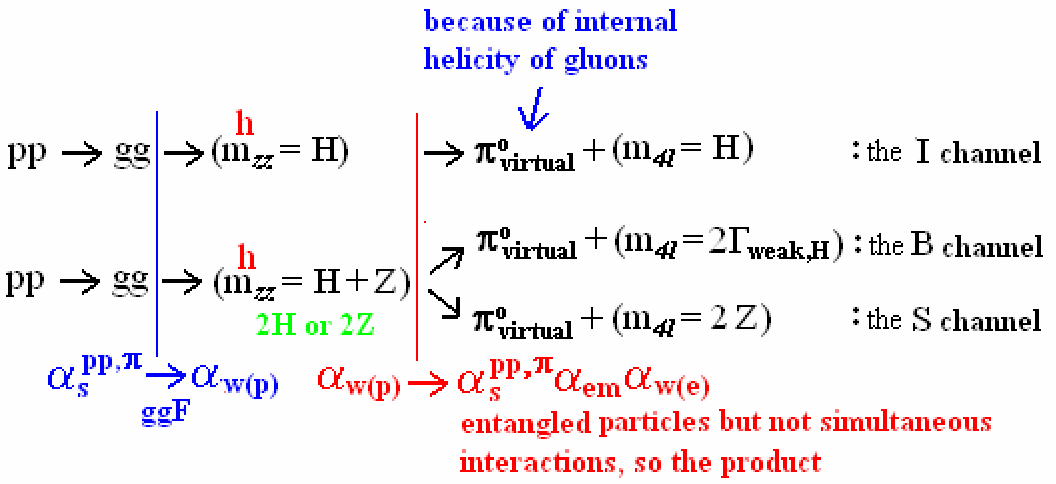

Fig.2. The threshold resonances.

SST shows that the weak coupling constant of the spacetime condensates is directly proportional to their radius, so due to the described transition, there are produced spacetime condensates with following radius

$$R_{new} = r_{C(p)} \left(\alpha_s^{pp,\pi} \, \alpha_{em} \, \alpha_{w(e)} / \alpha_{w(p)} \right) , \qquad (16)$$

where $r_{C(p)} = 0.8711018 \cdot 10^{-17}$ **m** is the radius of the scalar spacetime-condensate in the centre of the proton [3].

The change in cross section is

$$\Delta\sigma = \pi \, R_{new}^{2} - 0 . \qquad (17)$$

The change in mass is

$$\Delta m_{4l} = m_{4l} - 0 . \qquad (18)$$

So we have

$$d\sigma / dm_{4l} = \pi \, R_{new}^{2} / m_{4l} = \pi \, r_{C(p)}^{2} f^{2} \alpha_{em}^{2} \alpha_{w(e)}^{2} / m_{4l} =$$

$$= \sigma_o f^{2} \alpha_{em}^{2} \alpha_{w(e)}^{2} / m_{4l} = 6.7848 \cdot 10^{-2} / m_{4l} \ \textbf{[fb/GeV]} . \qquad (19)$$

The factor $f^2 \approx 0.6 \cdot 10^6$ in formula (19) (see formula (11)) causes that the increases in measured cross sections in the off-shell processes are enormous. There appear also the electroweak interactions of leptons ($\alpha_{em}{}^2\ \alpha_{w(e)}{}^2$).

For $m_{ZZ} = m_{4l} = H$ we obtain $(d\sigma/dm_{4l})_H = 5.4 \cdot 10^{-4}$ **[fb/GeV]** (it is for the initial (I) channel).

For $m_{ZZ} = H + Z$ and $m_{4l} = 2\Gamma_{weak,H}$ we obtain $(d\sigma/dm_{4l})_{H+Z} = 1.0 \cdot 10^{-2}$ **[fb/GeV]** (it is for the background (B) channel).

For $m_{ZZ} = H + Z$ and $m_{4l} = 2Z$ we obtain $(d\sigma/dm_{4l})_{H+Z} = 3.7 \cdot 10^{-4}$ **[fb/GeV]** (it is for the signal (S) channel).

We can see that there is the split of the $m_{ZZ} = H+Z$ state into the B and S states and that there dominates the B state.

Our results are consistent with the ATLAS and CMS simulations [2].

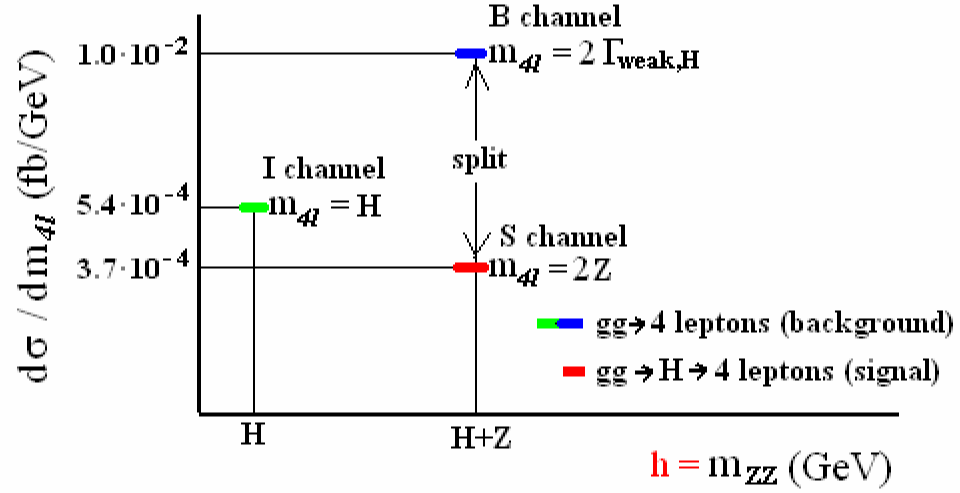

Fig.3. The split of the (2H+2Z)/2 = H+Z state into the B and S channel.

7. Internal structure and couplings of H, W$^\pm$, Z and heavier spacetime condensates and their production and decays

The scalar or vector spacetime condensates that interact due to the nuclear weak interactions (the coupling constant is $\alpha_{w(p)}$) are the SST weak black holes (WBHs) composed of the $Y = 424.12$ **MeV** spacetime condensates which are the elementary WBHs (EWBHs). Such granular structure of the WBHs causes that for all of them the weak coupling constant is invariant and is equal to $\alpha_{w(p)}$. The EWBHs in a WBH are entangled because they exchange the virtual EWBHs. The EWBHs can exchange a single spin-1 electron-(electron-antineutrino) pair as it is in the $W^\pm$ or spin-1 electron-positron pair as it is in the Z, so there appear the electroweak interactions (the coupling constant is $\alpha_{em}\alpha_{w(e)}$). But the EWBHs can be produced in the gluon-gluon fusion because of the circle-diameter transitions of two FGLs [3], so there can appear the strong-electroweak interactions (the coupling constant is $\alpha_s{}^{pp,\pi}\alpha_{em}\alpha_{w(e)}$).

Radius, $R_{WBH,sphere}$, of the sphere of a WBH with a mass of M_{WBH} on which the virtual spacetime condensates are moving with the spin speed equal to c is

$$R_{WBH,sphere} = G_w\, M_{WBH} / c^2\,, \tag{20}$$

where $G_w = 1.03550248 \cdot 10^{27}$ **m³/(kg s²)** [3].

Emphasize that $R_{WBH,sphere}$ is not the radius, R_{WBH}, of the sphere filled with the EWBHs. Moreover, the effective radius (so cross section as well) depends on coupling constants as it is in formula (16).

At high energies of the pp collisions, the gluon loops produced on the equator of the core of baryons have the range equal to $R = 2\pi A \approx 4.38$ **fm**. The granular nuclear weak black hole with such a radius ($R_{WBH,sphere} = R$) has a mass of (see formula (20))

$$M_{WBH} = 2 \pi A c^2 / G_w \approx 213.36 \text{ GeV} . \qquad (21)$$

It means that we have a resonance for the HV production, where V is close to the mean mass of the vector bosons: $(W^{\pm} + Z)/2 \approx 86$ **GeV** (i.e. 125 **GeV** + 86 **GeV** = 211 **GeV** ≈ 213 **GeV**) but notice that the uncharged HZ state (~216 **GeV**) is preferred as it is in Fig.3.

On the other hand, for $R = 2\pi(A+B) \approx 7.535$ **fm** [3] we obtain 2·183 **GeV** ≈ 2(2Z), so the control region (CR) for the Higgs-boson off-shell production should be from 183 **GeV** (~2Z) up to 216 **GeV** (~HZ). The CR in the ATLAS experiment was from 180 **GeV** up to 220 **GeV**, so it is close to the SST resonance/split region.

Radius of the last orbit for the nuclear strong interactions is $R = A+4B = 2.7048$ **fm** that corresponds to energy equal to

$$M_{WBH} = (A + 4B) c^2 / G_w \approx 131.69 \text{ GeV} . \qquad (22)$$

We see that there is 131.7 **GeV** ≈ $H + 2\Gamma_{weak,H}$ = 131.6 **GeV**, so there appears the $2\Gamma_{weak,H}$ resonance for the HZ state as it is in Fig.3. We see that there dominate two resonances: for the A (the equatorial effects leading to HZ) and for the A+4B (the peripheral effects in background leading to $2\Gamma_{weak,H}$) states as it should be at high energies!

Emphasize also that due to the **four-particle/object symmetry** described in SST [3], because of the gluon-gluon collapses/fusions in centres of the colliding protons, there are produced not only the Y spacetime condensates and the Higgs bosons, but also the virtual quadrupoles of neutral pions which the quantized range is equal to A, so the quantized range of virtual single neutral pions is $4A \approx 2.79$ **fm**, i.e. is peripheral! It means that at the peripheral distance, there appear the $H + 2\Gamma_{weak,H}$ (the H can decay to $4l$ or $2l2\nu$) and the virtual neutral pions – such is the origin of the $\alpha_s^{pp,\pi}\alpha_{em}\alpha_{w(e)}$ coupling constant. The **ggF →** $\Gamma_{weak,H}$ (see also formula (8)), due to the $\alpha_s^{pp,\pi} \rightarrow \alpha_{w(p)}$ transition, reduces mass of the $\Gamma_{weak,H}$ to $\Gamma_{weak,H,illusory}$ = 4.3 **MeV**. Such is the origin of the illusory total width of the Higgs boson.

Notice also that there can be created Higgs bosons with not quantized masses ($h = m_{ZZ}$ – see the x-axis in Fig.3) but the lack of quantization causes that they very quickly decay to the Y spacetime condensates or, due to the four-object symmetry, they can decay to one or more groups of 4 fermions.

We see that we cannot explain fully the dynamics in the ATLAS experiment without the atom-like structure of baryons described in the Scale-Symmetric Theory. We showed that the peripheral interactions at high energies are very important.

The virtual pseudoscalar composed of the two spin-1 fundamental gluon loops causes that there appear the hypotheses with spin-2 or negative-parity of the Higgs boson.

The coupling constant for the dark-matter loops interacting with the Y spacetime condensates in baryons (the ground state of the Higgs bosons) is $2\alpha_{w(e)}$ [3].

We predict that there is the third Higgs boson with the quantized mass ~17.2 **TeV** (there are Y, H and C ≈ 17.2 **TeV** [3].

8. Off-shell/on-shell couplings

The joint off-shell ($4l + 2l2\nu$ channel) and on-shell (only $4l$ channel) analysis in the ATLAS experiment leads to following two parameters [2]

$$R_{gg,ATLAS} = \kappa_{g,off\text{-}shell}^{2} / \kappa_{g,on\text{-}shell}^{2} = 1.37^{+0.92}_{-1.33} \,, \qquad (23)$$

$$R_{VV,ATLAS} = \kappa_{V,off\text{-}shell}^{2} / \kappa_{V,on\text{-}shell}^{2} = 0.9^{+0.42}_{-0.35} \,, \qquad (24)$$

On the other hand, we have

$$R_{gg,SST} = H \text{ (the ggF production)} / Z = 1.37 \,, \qquad (25)$$

$$R_{VV,SST} = W^{\pm} \text{ (the EW} \rightarrow W_{nuclear} \text{ production)} / Z = 0.88 \approx 0.9 \,. \qquad (26)$$

We see that the central values in (23) and (24) are equal to our values in (25) and (26). In the definitions of such parameters, there appear the gluons and bosons and the on-shell and off-shell processes, so from the same values in (23) & (25) and (24) & (26) follows that in the ATLAS selected decays, there dominated characteristic bosons.

We also have

$$\Gamma_{weak,\ H,illusory} / \Gamma_{H}^{SM} \approx 1.05 \,. \qquad (27)$$

9. Summary

Here we showed that the ATLAS measured total width of the off-shell Higgs bosons is a value that does not concern the Higgs bosons but the SST weak total width of the Higgs boson 3.3 **GeV**, and we see that the 4.3 **MeV** value appears because of the transition from the nuclear strong interactions to the nuclear weak interactions.

The main conclusion is as follows. Mean mass of the virtual spin-0 particles surrounding the Higgs boson is 3.3 **GeV**, so such mean mass have also the virtual gluon-gluon (gg) pairs. Transitions from the gluon-gluon pairs (the gluon-gluon fusion ggF) to electroweak (EW) condensates (such as for example the $W^{\pm}$ bosons) cause that there appear the spacetime condensates with a mass $M_{Pretending\text{-}to\text{-}be} = \Gamma_{weak,H}\alpha_{w(p)}/\alpha_{s}^{pp,\pi} = 4.3$ **MeV** "pretending to be" the real total width of the Higgs boson (i.e. 3.3 **GeV**). Notice also that $\alpha_{w(p)}$ (i.e.

$W_{nuclear}$) >> $\alpha_{em}\alpha_{w(p)}$ (i.e. $EW_{nuclear}$) >> $\alpha_{em}\alpha_{w(e)}$ (i.e. $EW_{leptons}$), so the nuclear weak interactions overwhelmingly dominate over the electroweak interactions, so we have $EW \rightarrow W_{nuclear}$.

We showed here that in the off-shell processes, the interference effects between the background ($gg \rightarrow ZZ$) and signal processes ($gg \rightarrow h \rightarrow ZZ$) is via the virtual neutral pion (it is a pseudoscalar $J^P = 0^-$) that carries the initial internal helicity of the gluons. Such interference is large because $\alpha_s^{pp,\pi} / \alpha_{w(p)} \approx 769$.

The two different central values, i.e. the ATLAS 4.6 **MeV** (according to SST, it is for H) and the CMS 3.2 **MeV** (according to SST, it is for Z) {or our prediction for $W^\pm$ bosons equal to 2.7 **MeV**}, additionally validate our model.

We calculated here also the second value for mass of the Higgs boson: 125.29 **GeV** (the first value is 125.006 **GeV** [3]).

The Scale-Symmetric Theory shows that the detected in 2012 Higgs boson is not the Standard-Model boson. Unlike the SST Higgs field, Nature works fine without the Higgs boson, so there is no point in defending its Standard-Model properties at all costs. The Standard-Model full width of the Higgs boson equal to 4.1 MeV is not realized by Nature, so we need new physics beyond the SM. We showed many times that the Scale-Symmetric Theory is the lacking part of the theory of everything.

References

[1] R. L. Workman, *et al.* (Particle Data Group)
Prog. Theor. Exp. Phys. **2022**, 083C01 (2022)

[2] ATLAS Collaboration (15 November 2022). ”Higgs total width at the ATLAS experiment”
CERN seminar; Rafael Coelho Lopes De Sá
https://indico.cern.ch/event/1187940/

[3] Sylwester Kornowski (7 October 2022). ”Particles, Cosmology and Applications: Scale-Symmetric Theory (SST)”
http://vixra.org/abs/2110.0171v2

[4] ATLAS Collaboration (1 July 2022). ”Measurement of the Higgs boson mass in the H→ ZZ* → 4*l* decay channel using 139 fb^{-1} of $\sqrt{s} = 13$ TeV *pp* collisions recorded by the ATLAS detector at the LHC”
arXiv:2207.00320 [hep-ex]

[5] CMS Collaboration (20 October 2022). “Measurement of the Higgs boson width and evidence of its off-shell contributions to ZZ production”
Nat. Phys. **18** (2022) 1329-1334
https://doi.org/10.1038/s41567-022-01682-0
arXiv:2202.06923v2 [hep-ex]

Sylwester Kornowski
I am a physicist.
I graduated in physics at the Poznań University (UAM) 1971, Poland.
E-mail: sylwester.kornowski@gmail.com