The Composite Sham Higgs Boson with a Mass of 125 GeV in the Scale-Symmetric Physics

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Abstract: The Scale-Symmetric Physics shows that the detected mainstream Higgs boson with a mass of 125 GeV is a composite particle. Due to the Mexican-hat mechanism, it consists of the confined luminal Einstein-spacetime components i.e. of the still undetected neutrino-antineutrino pairs (their gravitational mass is in an approximation the inverse of 67 powers of ten kilograms). It is not true that the mainstream sham Higgs boson can consist of more massive condensates - it follows from the fact that due to the Mexican-hat mechanism and very high dynamic pressure, all Type sham-Higgs-boson condensates have practically the same gravitational-mass density so more massive condensates have bigger radius. But the non-gravitating energy frozen in each Einstein-spacetime component is about 119 powers of ten higher than its gravitational mass. The geometric mean of the non-gravitating energy and the gravitational mass of an Einstein-spacetime component is close to the Planck mass - it solves the hierarchy problem. Here we calculated the rigorous radius of the mainstream Higgs boson and the coupling constants which follow from the Mexican-hat mechanism (i.e. from the confinement) and from the quantum entanglement. They are the fifth and sixth forces. The quantum-entanglement coupling constant depends on distance. The coupling constant for the shortest-distance quantum entanglement is about 92 powers of ten and is responsible for the very stable structure of the torus-charge inside the core of baryons - it is the reason that the core of proton is practically indestructible. On the other hand, the coupling constant responsible for the confinement is the inverse of 15 powers of ten so the condensates are the very unstable particles.

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 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 and described the Higgs mechanism, quantum entanglement and confinement [1], [2], [3], [4], [5], [6], [7], [8], [9].

Here, applying the S-SP we calculated the rigorous radius of the mainstream Higgs boson and the coupling constants which follow from the Mexican-hat mechanism (i.e. from the confinement) and from the quantum entanglement. They are the fifth and sixth forces. The quantum-entanglement coupling constant depends on distance. The coupling constant for the
shortest-distance quantum entanglement is about $\alpha_{\text{d-E}} = 3.1 \cdot 10^{92}$ and is responsible for the very stable structure of the torus-charge inside the core of baryons – it is the reason that the core of proton is practically indestructible. On the other hand, the coupling constant responsible for the confinement is $\alpha_C = 1.9 \cdot 10^{-15}$ so the condensates are the very unstable particles.

2. Calculations

All needed here quantities are calculated within S-SP [1].

According to S-SP, in the proton are three super-dense fields composed of entangled or/and confined neutrino-antineutrino pairs i.e. of the carriers of gluons (gluons are the rotational energies of the pairs). In the core of proton is the torus/charge composed of entangled carriers of gluons – it is the shortest-distance entanglement i.e. the distances between carriers of gluons are $2\pi$ times greater than the external radius of a neutrino. In the centre of the torus is a condensate (its mass is $Y = 424.12$ MeV) composed of confined carriers of gluons – it is due to the Mexican-hat mechanism. Outside the core of proton is a relativistic pion in the S state. Radius of the central condensate is $r_{p(\text{proton})} = 0.871 \cdot 10^{-17}$ m. Mass of the Einstein spacetime (it consists of the free carriers of gluons and photons [1]) which overlaps with the central condensate, when the carriers of gluons are confined, is about $M^*_H = 17.1$ TeV and it is a more massive sham Higgs boson. Due to the Mexican-hat mechanism and the very high dynamic pressure in the Einstein spacetime (about $10^{45}$ Pa [1]), mass density of all Type Higgs-boson condensates is practically the same so we can calculate the rigorous radius of the Higgs boson, $R_H$, with a mass of $M_H = 125$ GeV

$$R_H = r_{p(\text{proton})} \left( \frac{M_H}{M^*_H} \right)^{1/3} = 1.69 \cdot 10^{-18} \text{ m.}$$

The coupling constant for all types of interactions (so for confinement and quantum entanglement as well) is defined within S-SP as follows ([1]: formula (76))

$$\alpha_i = G_i M_i m_i / (v \hbar),$$

where $M_i$ defines the sum of the mass of the sources of interaction being in touch plus the mass of the component of the field, $m_i$ defines the mass of the carrier of interactions whereas $v$ is the speed of exchanged particle.

On the other hand, the constants of interactions, $G_i = g \rho_i$, are directly proportional to the inertial mass densities of fields carrying the interactions, $\rho_i$, whereas $g = 25,224.563 \text{ m/(kg}^2 \text{s}^2 \text{)}$ ([1]: formulae (11) and (12)).

In a condensate, a carrier of gluon occupies a cube with a side about $L_C \approx 3.90 \cdot 10^{-32}$ m [1]. The non-gravitational energy frozen inside one carrier of gluon is $E_g = 2 \cdot 1.96 \cdot 10^{52}$ kg ([1]: Table 2). It leads to the mean density of the field responsible for the confinement, $\rho_C$,

$$\rho_C = E_g / L_C^3 = 6.6 \cdot 10^{146} \text{ kg/m}^3.$$

The luminal carriers of gluons consist of the superluminal binary systems of closed strings (entanglons) which are responsible for the confinement and quantum entanglement. The non-gravitational energy of entanglon is $E_E = 4.68 \cdot 10^{87}$ kg ([1]: Table 2) whereas its superluminal speed is $v = v_E = 0.727 \cdot 10^{68}$ m/s ([1]: Table 2). Gravitational mass of the carrier of gluon is $M_i = M_g = 6.67 \cdot 10^{-67}$ kg (mass of the component of field, i.e. mass of
entanglon we can neglect). But due to the confinement there are exchanged all entanglons (it is the volumetric interaction) so the mass of the carrier of interactions is the mass \( m_i = M_g \). It leads to the coupling constant for the confinement, \( \alpha_C \),

\[
\alpha_C = g \rho_C 2 M_g M_g / (v_E h) = 1.9 \cdot 10^{-15}. \tag{4}
\]

The calculated coupling constant which follows from the confinement is very small so the Type Higgs-boson condensates are very unstable.

On the surface of the torus in the core of baryons, a carrier of gluon occupies a rectangular prism in which two sides are equal to \( L_{E,1} \approx 2 \pi r_{\text{neutrino}} = 7.03 \cdot 10^{-35} \text{ m} \) whereas the third side is \( L_{E,2} \approx 2 r_{\text{neutrino}} (\pi + 1) / 3 = 3.09 \cdot 10^{-35} \text{ m} \). It leads to the mean density of the field responsible for the shortest-distance quantum entanglement, \( \rho_E \),

\[
\rho_E = E_g / (L_{E,1}^2 L_{E,2}) = 2.6 \cdot 10^{155} \text{ kg/m}^3. \tag{5}
\]

For the quantum entanglement are responsible exchanges of single superluminal entanglons (it is the directional interaction) so the non-gravitational energy of the carrier of interactions is the energy \( m_i = M_E = E_E (v_E / c)^2 = 2.75 \cdot 10^{32} \text{ kg} \). It leads to the coupling constant for the quantum entanglement, \( \alpha_E \),

\[
\alpha_E = g \rho_E 2 M_g M_E / (v_E h) = 3.1 \cdot 10^{92}. \tag{6}
\]

The coupling constant which follows from the quantum entanglement is very big so the torus inside the core of baryons is practically indestructible. The mean spin speed of the torus is \( 2c/3 \). Since the carriers of gluons are luminal so in the core of baryons appear the radial speeds of the carriers of gluons. Their collisions in centre of the torus lead to the central condensate. Since the very unstable condensate is produced by the indestructible torus so the cores of baryons as a whole are indestructible as well.

3. Summary

We know that an alternative to SUSY is composite Higgs i.e. Higgs composed of more fundamental particles but we need a fifth force between the new fundamental particles – it is the confinement described in this paper. The confinement follows from the Mexican-hat mechanism described within the Scale-Symmetric Physics and such mechanism concerns the luminal Einstein-spacetime components which are the new fundamental particles the Higgs boson consists of. But due to the very small coupling constant associated with the confinement (\( \sim 1.9 \cdot 10^{-15} \)), the condensates are the very unstable particles – it does not concern the central condensate in core of baryons because such condensate is created by the indestructible torus/charge.

Calculated here the radius of the mainstream sham Higgs boson with a mass of 125 GeV is about \( 1.69 \cdot 10^{-18} \text{ m} \).

Calculated here the coupling constant for the shortest-distance quantum entanglement is about \( 3.1 \cdot 10^{92} \). This value is very big so destruction of the torus/charge of baryons by the other interactions is impossible. It is the reason that inside nucleons are the three super-dense gluon fields.

From the Scale-Symmetric Physics follows that the constituents of the composite Higgs have not gravitational mass around TeV, their mass is very small – it is the mass of the carriers of gluons (\( \sim 6.67 \cdot 10^{-67} \text{ kg} \)). But the non-gravitational energy frozen inside the
carriers of gluons is about $0.6 \cdot 10^{119}$ times greater than their gravitational mass. It is the reason that the shortest-distance quantum entanglement is such tremendously strong.

The hierarchy problem (or naturalness) is wrongly understood. The S-SP shows that we do not need mass around TeV to solve the hierarchy problem. Just the correct interpretation of the hidden energy which follows from the mainstream quantum physics, which is about $10^{122}$ times higher than the observed one (it is the non-gravitational energy frozen inside the carriers of gluons and photons), solves the hierarchy problem. But there should be in existence at least one Type Higgs-boson condensate with mass about 17.1 TeV. Mass densities of such condensates are the same so radius of the 17.1 TeV condensate is bigger than the mainstream Higgs boson and is in an approximation $0.87 \cdot 10^{-17}$ m. Such condensates cannot be inside the mainstream Higgs boson.

The Planck mass is in reality close to the geometric mean of the gravitational mass and the tremendous non-gravitational energy frozen inside the carriers of gluons and photons i.e. frozen inside the Einstein-spacetime components (i.e. frozen inside the still undetected neutrino-antineutrino pairs).

Presented here the Composite Higgs Model (CHM) is characterized by the mass of the lightest new particle and its coupling.

References