A Light, Neutral Boson with a Mass of 18.4 MeV as the Binder of the Second Composite Higgs Boson with a Mass of 742 GeV or/and 750 GeV and the Tetraneutron

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Abstract: Applying the Scale-Symmetric Theory (SST), which describes the phase transitions of the inflation/Higgs field, we show that a light, neutral boson with a mass of 18.4 MeV that consists of four entangled parts (theory of neutrinos described within SST shows that there is valid the four-object symmetry), is the binder/precursor of the second Higgs boson with a mass of 742 GeV or/and 750 GeV. The ATOMKI group has adequate equipment to detect the light, neutral boson with a mass of about 18.4 MeV whereas the LHC experiments can show which one of the two possible mass states of the second composite Higgs boson dominates. The four-object symmetry and the atom-like structure of baryons lead to the resonant tetraneutron state and to the internal structure of the neutron stars/black-holes.

1. Introduction and calculations

Here, applying the Scale-Symmetric Theory (SST) [1], we describe the phenomena responsible for creation of the second composite Higgs boson with a mass of 742 GeV or/and 750 GeV and for creation of the resonant tetraneutron state.

The General Relativity leads to the non-gravitating Higgs field composed of tachyons [1A]. On the other hand, SST shows that the succeeding phase transitions of such inflation/Higgs field lead to the different scales of sizes/energies [1A]. Due to a few new symmetries, there consequently appear the superluminal binary systems of closed strings (the entanglons) responsible for the quantum entanglement, four stable neutrinos (electron-neutrino, muon-neutrino and their antineutrinos are stable whereas tau-neutrino and its antineutrino are unstable [1A]) and luminal neutrino-antineutrino pairs which are the components of the luminal Einstein spacetime (it is the Planck scale), cores of baryons, and the cosmic structures that evolution leads to the dark matter, dark energy and expanding universes [1A], [1B]. The non-gravitating tachyons have infinitesimal spin so all listed structures have internal helicity (helicities) which distinguish particles from their antiparticles [1A].

During the inflation, the liquid-like inflation/Higgs field transformed partially into the luminal Einstein spacetime [2].

Due to the symmetrical decays of bosons on the equator of the core of baryons, there appears the atom-like structure of baryons described by the Titius-Bode (TB) orbits/tunnels/loops for the nuclear strong-weak interactions [1A].

The coupling constant for the two shortest-distance quantum entanglement is very big (about $3 \cdot 10^{92}$) so the core of the baryons is practically indestructible [1A]. It causes that the liquid-like nuclear plasma consists of the cores [1A]. In such plasma, there are produced first of all pions, kaons and relativistic electrons in the $d = 0$ ground state which is tangent to the equator of the core of baryons [1A]. Relativistic mass of the $d = 0$ electrons is about $F = 9.00362$ times higher than their bare mass ($m_{bare(electron)} = 0.510407011$ MeV) [1A].

Fermions have spin and internal helicity. The objects composed of four different stable neutrinos lead to the four-fermion symmetry – such objects can have total spin and internal helicity simultaneously equal to zero [1A]. Due to the quantum entanglement, such symmetry leads to the four-object symmetry as well [1B], [1A]. The groups of entangled four stable neutrinos or four bosons each composed of two different fermions (for example, of two electrons each entangled with electron-antineutrino and two positrons each entangled with electron-neutrino) do not create turbulences in the Einstein spacetime [1A] – it is the origin of the four-object symmetry. Such relativistic objects can appear in the $d = 0$ state.

Mass of the Einstein spacetime corresponding to energy equal to E is $f = 40{,}362.942$ times higher [1A]. This mass can be entangled with the energy E so it can be detected.

The above remarks lead to conclusion that there can be produced scalar condensates composed of four entangled parts. Mass of one of such condensates is [3], [4]

$$M_{Second\text{-}Higgs} = 4\, m_{bare(electron)}\, F\, f = 741.95 \text{ GeV} \approx 742 \text{ GeV}. \quad (1)$$

Such a scalar condensate can decay into two photons or four or eight leptons.

Assume that ΔM_{pion} is the mass distance between charged and neutral pion – the SST gives [1A]

$$\Delta M_{pion,SST} = (m_{pion(+,-)} - m_{pion(o)})_{theory(SST)} = 4.59367 \text{ MeV}. \quad (2)$$

This SST value is very close to experimental data [5]

$$\Delta M_{pion,experiment} = (m_{pion(+,-)} - m_{pion(o)})_{experiment} = 4.5936 \pm 0.0005 \text{ MeV}. \quad (3)$$

There can be produced a second scalar condensate with a mass $M^*_{Second\text{-}Higgs}$ composed of four entangled parts, [6], close to 750 GeV estimated in experiments with a significance level of about 2σ [7]

$$M^*_{Second\text{-}Higgs} = 4\, \Delta M_{pion,SST}\, f = 741.66 \text{ GeV} \approx 742 \text{ GeV}. \quad (4)$$

Notice that the light, neutral boson X with a mass of M_B

$$M_B = 4\, \Delta M_{pion,SST} = 18.375 \text{ MeV} \approx 18.4 \text{ MeV} \quad (5)$$

is the binder/precursor of the second composite Higgs boson with a mass of 742 GeV.

The theory of hyperons described within SST shows that in the $d = 2$ TB state there, due to the quantum entanglement, can appear the pion-gluon (πg) pairs that can transform into the pion-photon ($\pi\gamma$) pairs [1A]. It means that there can appear Higgs-gluon (Hg) pairs with energy of gluon equal to the half of the mass of the first composite Higgs boson i.e. $g = H/2$

= 62.5 GeV. This leads to conclusion that the *Hg* pairs carry mass equal to 187.5 GeV. Since the binder/precursor *X* consists of four entangled parts so there can be produced a Higgs boson composed of four *Hg* pairs i.e. its mass is 750 GeV.

The ATOMKI group has adequate equipment, [8], to detect the light, neutral boson with a mass of about 18.4 MeV whereas the LHC experiments can show which of the two possible mass states of the second Higgs boson (742 GeV or 750 GeV) dominates.

Between neutrons can be exchanged condensates produced by the condensates in centers of electrons – their mass is $M_{C(electron)}$ = 0.2552 MeV [1A]. The four-object symmetry leads to conclusion that the energy $\Delta E_{Tetraneutron}$ of tetraneutron state above the threshold of four-neutron decay should be

$$\Delta E_{Tetraneutron} = 4\ M_{C(electron)} = 1.021\ \text{MeV}. \quad (6)$$

This result is consistent with experimental data but their accuracy is very low (0.83 ± 1.90 MeV) [9]. Such interactions can lead to the theory of neutron stars/black-holes described within SST [1B].

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