An Extension of the Dynamics of the Core of Baryons

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Abstract: Presented here an extension of the dynamics of the core of baryons reduces the initial 3 iterative numbers in the Scale-Symmetric Theory (SST) to 2. Now SST starts from 7 parameters and 2 iterative numbers which are derived after formulation of the theory. We calculated mass of the central condensate which is responsible for the nuclear weak interactions, the coupling constant for such interactions, the binding energy of the torus/electric-charge and central condensate, and masses of charged and neutral core. We showed also how important are the axial symmetries in weak interactions.

1. Introduction

The dynamics of the core of baryons is partially described within the Scale-Symmetric Theory (SST) [1]. In [2], applying the dynamics of the core, we showed the origin of the two gamma-ray absorption lines measured by researchers from Osaka University [3] and of the two gamma-ray peaks in best-fit model for the time-integrated photon spectrum (3.3 s – 21.6 s) [4].

Here we present an extension of the dynamics of the core of baryons. We reduced the 7 initial parameters plus 3 initial iterative numbers applied in SST [1] to 7 parameters plus 2 iterative numbers. Notice that the initial iterative numbers are calculated after formulation of the SST so they are not the real parameters. We introduced them to simplify the mathematical description. We can neglect the iterative numbers but it causes that we must solve systems of equations with many variables. We calculated also a few quantities characteristic for the core and we showed importance of the axial symmetries in weak interactions.

The core of baryons consists of the spin-1/2 torus/electric-charge with a mass of $X^{+,-}$ = 318.2955 MeV (such a mass we calculated from initial parameters without any iterative number) and of the spin-zero scalar condensate with a mass of Y = 424.1245 MeV (such a mass we calculated applying the initial parameters and 3 iterative numbers) [1]. Inside the torus are created the large loops (with a mass of m_{LL} = 67.54441 MeV) which are responsible for the nuclear strong interactions (the neutral pion, π^o = 134.97674 MeV, is the spin-zero binary system of interacting electromagnetically large loops) – we can calculate mass of the large loop from $X^{+,-}$ [1]

$$m_{LL} = 2\, X^{+,-} / (3\pi)\,. \qquad (1)$$

To eliminate one of the three initial iterative numbers, we must calculate the mass Y and coupling constant for the nuclear weak interactions, $\alpha_{W,proton}$ = 0.018723, using the initial parameters and the iterative numbers F_1 = 1.0011596522 (it is the ratio of mass of the electron to its bare mass) and $F_2 = 2.285423$ (it is the ratio of the mass of the core of baryons to mass of the torus) [1].

2. Mass of the central condensate

Range of the large loop, so of the neutral pion as well (it is responsible for the strong interactions), is $2\pi R$, where R is the radius of the loop. It follows from the rolling-unrolling mechanism characteristic for the virtual (or real) large loops. On the other hand, range is inversely proportional to mass so a transition from the spin motion of the large loop to vibrations along its radius increases mass 2π times

$$Y^* = 2 \pi m_{LL} = 424.39405 \text{ MeV} . \quad (2)$$

From the Stefan-Boltzmann law we have

$$j^* \sim T^4 , \quad (3)$$

where j^* is the total energy radiated per unit surface area of a black body across all wavelengths per unit time (the radiant emittance), and T is the black body's thermodynamic absolute temperature. The radiant emittance is the radiant flux emitted by a surface per unit area. We have

$$j^* \sim E_{Emitted} , \quad (4)$$

where $E_{Emitted}$ is the emitted total energy.

We know that emitted energy is directly proportional to four powers of temperature while from the Wien's displacement law we have that absolute temperature is inversely proportional to wavelength (which, here, decreases from $2\pi R$ to R) i.e. emitted energy is directly proportional to $1/(2\pi)^4$

$$E_{Emitted} = -Y^* / (2\pi)^4 = 0.2723014 \text{ MeV} . \quad (5)$$

On surface of the Y condensate, the Einstein-spacetime components are moving with the speed of light in "vacuum" c. It suggests that to create the Y condensate, the initial radius of it must be smaller than the Schwarzschild radius for the weak interactions i.e. must be smaller than the radius of Y multiplied by 2. The Schwarzschild radius for weak interactions is about 27 times lower than the radius of the large loop [1]. It means that the transition from R to $R/(2\pi)$ does not lead to Y. We need the second transition but emphasize that wavelength is equal to size of the created ball so we have $2[1/(2\pi)]^2 = 1/(2\pi^2)$. The total density inside the ball is higher than density of the Einstein spacetime so the associated energy is the absorption energy. We have

$$E_{Absorbed} = +Y^* / (2\pi^2)^4 = 0.0027954 \text{ MeV} . \quad (6)$$

The total mass of the condensate Y is

$$Y = 2 \pi m_{LL} \{1 - E_{Emitted} + E_{Absorbed}\} = 424.12454 \text{ MeV} . \quad (7)$$

We can see that we calculated the mass Y taking into account only the dynamics of the core of baryons.

3. Coupling constant for the nuclear weak interactions

Now we must calculate from the dynamics of the core of baryons the coupling constant for the nuclear weak interactions i.e. the $\alpha_{W,proton} = 0.018723$ [1].

The core of baryons is created due to the nuclear weak interactions. The weak coupling constant is a relative coupling which is the ratio of the initial state and the final state

$$\alpha_{Relative} = \alpha_{W,proton} = \alpha_{Initial} / \alpha_{Final} . \quad (8)$$

In SST, the coupling constant for the weak interactions is defined as follows [1]

$$\alpha_{W,i} = M_i R_i c / \hbar , \quad (9)$$

where M_i is the mass of scalar condensate, and R_i is its radius. R_i is directly proportional to wavelength so from (3) and (9) we have

$$\alpha_{W,i} \sim M_i / E_i^{1/4} , \quad (10)$$

where E_i is mass of the source of interactions while M_i is mass of the carrier of interactions.

From (8) and (10) we have

$$\alpha_{W,proton} = \alpha_{Initial} / \alpha_{Final} = [M_{Initial} / E_{Initial}^{1/4}] / (M_{Final} / E_{Final}^{1/4}] =$$

$$= [E_{Final} / E_{Initial}]^{1/4} / (M_{Final} / M_{Initial}] . \quad (11)$$

Here we have:

$E_{Final} = X^{+,-} + Y^* + (e^+ + e^-)_{bare}$, where $(e^+ + e^-)_{bare} = 1.0208$ MeV is the bare mass of the electron-positron pair produced by the charged torus $X^{+,-}$ outside it [1],

$E_{Initial} = X^{+,-}$,

$M_{Final} = \pi^o$, where $\pi^o = 134.97674$ MeV [1],

$M_{Initial} = 2(e^+ + e^-)$ which is the spin-zero pair of the spin-1 electron-positron pairs produced inside the charged torus. Such quadrupole does not violate the half-integral spin of the charged core. Here $e^{+,-} = 0.5109989$ MeV [1].

It leads to

$$\alpha_{W,proton} = 0.01872253 \approx 0.018723 . \quad (12)$$

4. Axial symmetries in weak interactions

To conserve the spin-1/2 and the unitary electric charge of the $X^{+,-}$ torus/electric-charge and the spin-zero and the electrical neutrality of the Y central condensate, the created virtual bare electron-positron pairs must be grouped in larger structures.

There must be created a group of 4 spin-1 pairs (an octopole) inside the volume of the condensate (see Fig.1). Such structure has three perpendicular axial symmetries what causes that its volumetric spin and volumetric electric charge are perfectly equal to zero.

There must be created a group of 2 spin-1 pairs (a quadrupole) near the surface of the torus (see Fig.2). Such structure has three axial symmetries what causes that its surface spin and surface electric charge are perfectly equal to zero.

There must be created a pair (a dipole) outside the torus which should be polarized along line of electric force (the lines are perpendicular to surface of the torus) (see Fig.3). Such structure has one axial symmetry overlapping with the axis of the dipole what causes that its linear electric charge is perfectly equal to zero. Spin of the dipole is unitary but it can be because the dipole is outside the core of baryons.

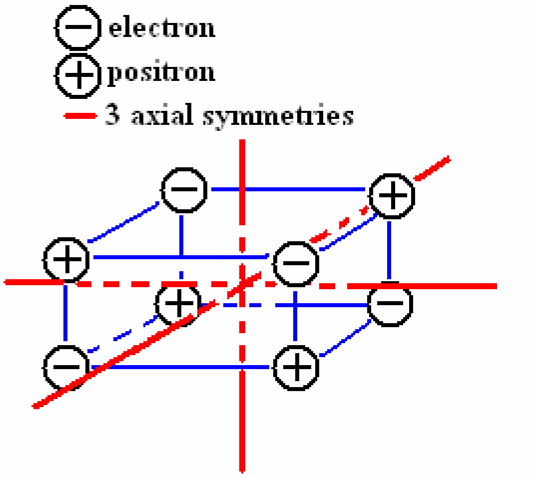

Fig.1. Four electron-positron pairs (octopole).

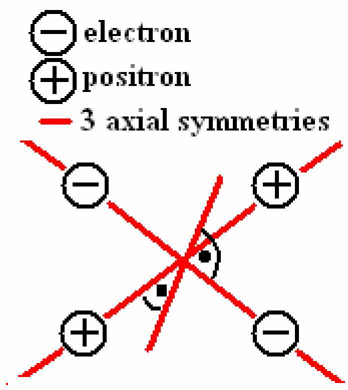

Fig.2. Two electron-positron pairs (quadrupole).

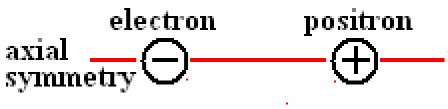

Fig.3. One electron-positron pair (dipole).

5. Binding energy of the $X^{+,-}$ torus and Y condensate

SST shows that the mean spin speed of the torus/electric charge is $v_{Spin} = 2c/3$ [1]. The resultant speed of the Einstein-spacetime components must be equal to c. It causes that the mean radial speed responsible for creation of the Y condensate is $v_{Radial} = 0.745356c$. In a transformation from spin speeds to radial speeds, the momentum must be the same so when we take into account the remarks in Paragraph **4** we obtain that involved energy is

$$E = [Y + 4(e^+ + e^-)_{bare}]\, v_{Radial} / v_{Spin} + [X^{+,-} + 2(e^+ + e^-)_{bare}] + (e^+ + e^-)_{bare} =$$

$$= 800.10886 \text{ MeV} . \qquad (13)$$

The core of baryons is created due to the weak interactions of the Einstein-spacetime components (i.e. the neutrino-antineutrino pairs) so the binding energy, ΔE, of the torus and central condensate is equal to the weak mass of the involved energy E

$$\Delta E = \alpha_{W,proton} E = 14.98006 \text{ MeV} . \qquad (14)$$

6. Masses of the charged, $H^{+,-}$, and neutral core, H^o, of baryons

Mass of the charged core of baryons is the sum of $X^{+,-}$ and Y minus the binding energy ΔE

$$H^{+,-} = X^{+,-} + Y - \Delta E = 727.4400 \text{ MeV} . \qquad (15)$$

Notice that now we can calculate the second iterative number applied in SST

$$F_2 = H^{+,-} / X^{+,-} = 2.285423 . \qquad (16)$$

The nucleons and pions are respectively the lightest baryons and mesons interacting strongly, so there should be some analogy between the carrier of the electric charge interacting with the core of baryons (it is the distance of masses between the charged and neutral cores) and the carrier of an electric charge interacting with the charged pion (this is the electron)

$$(H^{+,-} - H^o) / H^{+,-} = e^{+,-} / \pi^{+,-} , \qquad (17)$$

where $\pi^{+,-} = 139.57041$ MeV [1].

From (17) we have

$$H^o = 724.7767 \text{ MeV} . \qquad (18)$$

and

$$\Delta H = H^{+,-} - H^o = 2.6633 \text{ MeV} . \qquad (19)$$

7. The Titius-Bode law for the electroweak and strong interactions

Inside the core of baryons there dominate the nuclear weak interactions while outside it dominate the electroweak interactions which are embedded in the nuclear strong field which has internal helicity [1]. It leads to conclusion that the ratio of the constants A and B which are characteristic for the Titius-Bode law for baryons ($R = A + d\,B$, where $d = 0, 1, 2, 4$ [1]) , is defined as follows

$$A / B = (\alpha_{W,proton} + \alpha_{EM}) / \alpha_{W,proton} = 1.389763 , \quad (20)$$

where $\alpha_{EM} = 1/137.036$ is the fine-structure constant [1].

8. Summary

Here, using an extension of the dynamics of the core of baryons, we reduced number of the initial iterative numbers applied in SST from 3 to 2 and calculated characteristic quantities for the core.

The theory of the core of baryons described here allows us to formulate the complete theory of hadrons and leptons [1].

References

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