The Resonant Substructure of Strange B Meson within the Scale-Symmetric Physics

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Abstract: Here, the resonant substructure of strange B meson is studied. The study is based on the Scale-Symmetric Theory (SST) i.e. the lacking part of Theory of Everything. The Kasner solutions to the vacuum Einstein equations via the succeeding phase transitions of the superluminal non-gravitating Higgs field lead to the structure of the core of baryons and next to the atom-like structure of baryons. Here, within the phenomena characteristic for the core of baryons, we calculated the masses of the spin-1 and spin-3 charmed, strange D resonances with a mass of 2860 MeV. The calculated masses are respectively 2858.5 MeV and 2860.8 MeV (they are very close to the experimental central values) whereas to obtain the exact spins equal to 1 and 3 we need a broadening of masses respectively about +- 5.3 MeV and +- 0.9 MeV and it is as well consistent with experimental data.

1. Introduction

The General Relativity leads to the non-gravitating Higgs field composed of tachyons [1A]. On the other hand, the Scale-Symmetric Theory (SST) shows that the succeeding phase transitions of such Higgs field lead to the different scales of sizes [1A]. Due to the saturation of interactions via the Higgs field and due to the law of conservation of the half-integral spin that is obligatory for all scales, there consequently appear the superluminal binary systems of closed strings (entanglons) responsible for the quantum entanglement (it is the quantum-entanglement scale), stable neutrinos and luminal neutrino-antineutrino pairs which are the components of the luminal Einstein spacetime (it is the Planck scale), cores of baryons (it is the electric-charges scale), and the cosmic structures (protoworlds; it is the cosmological scale) that evolution leads to the dark matter, dark energy and expanding universes (the “soft” big bangs) [1A], [1B]. The non-gravitating tachyons have infinitesimal spin so all listed structures have internal helicity (helicities) which distinguishes particles from their antiparticles [1A]. During the inflation, the liquid-like inflation field (the non-gravitating superluminal Higgs field) transformed partially into the luminal Einstein spacetime (the big bang) [1A], [1B]. In our Cosmos, the two-component spacetime is surrounded by timeless wall – it causes that the fundamental constants are invariant [1A], [1B].

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 orbits for the nuclear strong interactions [1A].

Applying 7 parameters only and a few new symmetries we calculated a thousand of basic physical (and mathematical) quantities (there are derived the physical and mathematical constants as well) consistent or very close to experimental data and observational facts (http://vixra.org/author/sylwester_kornowski). In SST there do not appear approximations, mathematical tricks, and free parameters which are characteristic for the mainstream particle physics and mainstream cosmology.

To the modified Higgs field we can apply the Kasner metric, [2], that is a solution to the vacuum Einstein equations. The Kasner solutions we interpret as the virtual tori/cyclones and one-dimensional virtual oscillations which lead to virtual loops in the superluminal non-gravitating Higgs field [3].

At high-energy resonance production in electron-positron or pp collisions, the atom-like structure of baryons outside the core is destroyed so most important are phenomena which take place inside the core and on its surface. The core is composed of entangled and confined Einstein-spacetime components which are the carriers of gluons [1B]. The equatorial radius of the core is A = 0.6974425 fm [1A] and we say that relativistic particles on the equator are in the $d = 0$ state. Relativistic spin speed in the $d = 0$ state is $v = 0.993813c$ i.e. rest mass increases f = 9.003632 times [1A]. In distance $2A/3$, there are produced from the Einstein-spacetime components the large loops with mass m_{LL} = 67.5444 MeV [1A]. Interaction of two such loops gives the mass of neutral pion [1A].

Using the Uncertainty Principle, energy of a loop having a circumference equal to $2\pi \cdot 2A/3$ is 67.5444 MeV, therefore, for a length equal to A, the energy/mass is approximately m_A = 282.93 MeV [1A].

We apply the data from Particle Data Group [4].

2. Calculations

Consider following two structures of strange B mesons

$$B^o{}_S \rightarrow D^+ K^- \pi^+ + D^*{}_{s1}(2860)^-, \quad (1)$$

$$B^o{}_S \rightarrow D^+ K^- \pi^+ + D^*{}_{s3}(2860)^-. \quad (2)$$

Define the structures of the spin-1 and spin-3 charmed, strange D resonances with a mass of 2860 MeV as follows

$$D^*{}_{s1}(2860)^- \equiv D^- \pi^+ + S^-{}_1, \quad (3)$$

$$D^*{}_{s3}(2860)^- \equiv D^- \pi^+ + S^-{}_3. \quad (4)$$

There is possible following structure of $S^-{}_1$

$$S^-{}_1 \equiv m_{A,equator} + m_A + m_A e^- \nu_e = 849.30 \text{ MeV}. \quad (5)$$

The mass $m_{A,equator}$ = 282.93 MeV is moving along the equator of the core and it is the relativistic mass. There are two additional masses m_A and one of them is interacting with electron and electron-antineutrino – its mass is $m_A e^- \nu_{e,anti}$ = 283.44 MeV – both are in the rest. The three m_A masses are the product of decay of the structure which appears in spin-3 strange charmed meson (see formula (9); the mass of such structure is 851.61 MeV; in such decay the spin decreases from 3 to 1).

The spin of S^-_1 is the spin of $m_{A,equator}$ – we can calculate it from following formula

$$Spin_1 = m_{A,equator}\, A\, v = 1.048 \cdot 10^{-34}\ \text{Js} = 0.9938\ [\hbar]. \quad (6)$$

To obtain the unitary spin and because there are the three identical masses 283.93 MeV, the mass of $D^*_{s1}(2860)^-$ must be broadened by

$$\Delta D^*_{s1}(2860)^- = 3\, m_A\, (1 - Spin_1) \approx 5.3\ \text{MeV}. \quad (7)$$

From formulae (3), (5) and (7) we obtain that the mass of the spin-1 charmed strange D resonance is

$$M\, (D^*_{s1}(2860)^-) = 2858.5 \pm 5.3\ \text{MeV}. \quad (8)$$

This mass is consistent with experimental data [5]. The obtained mass is very close to the central value (2859.0) obtained in LHCb experiment. From formula (1) results that the right side is 5361.4 MeV i.e. it is about 5.4 MeV less than the mass of the strange B meson i.e. such decay is possible.

There is possible following structure of S^-_3

$$S^-_3 \equiv (2\pi^o / 3 + e^-_{d=0} \nu_{e,anti})_{d=0} = 851.61\ \text{MeV}. \quad (9)$$

The pion appears as two circles with radius $2A/3$. The transition of these two large loops to $d = 0$ state (the radius is A) causes that mass of the pion is 2/3 of the rest mass. Next, it interacts with electron and electron-antineutrino in $d = 0$ state i.e. the mass of electron increases $f = 9.003632$ times. The total rest mass is $m = 94.5852$ MeV. In the $d = 0$ state its mass increases f times so it leads to 851.61 MeV.

The spin of S^-_3 is

$$Spin_3 = S^-_3\, A\, v = 3.1544 \cdot 10^{-34}\ \text{Js} = 2.991\ [\hbar]. \quad (10)$$

To obtain the spin equal to 3, the mass of $D^*_{s3}(2860)^-$ must be broadened by (the broadening concerns the rest mass $m = 94.5852$ MeV only so the broadening for the spin-3 resonance is lower)

$$\Delta D^*_{s3}(2860)^- = m\, (3 - Spin_3) \approx 0.9\ \text{MeV}. \quad (11)$$

From formulae (4), (9) and (11) we obtain that the mass of the spin-3 charmed strange D resonance is

$$M\, (D^*_{s3}(2860)^-) = 2860.8 \pm 0.9\ \text{MeV}. \quad (12)$$

This mass is consistent with experimental data as well [5]. The obtained mass is very close to the central value (2860.5) obtained in LHCb experiment. From formula (2) results that the right side is 5363.7 MeV i.e. it is about 3.1 MeV less than the mass of the strange B meson i.e. such decay is possible.

3. Summary

Here, the resonant substructure of strange B meson is studied. The study is based on the Scale-Symmetric Theory (SST) i.e. the lacking part of Theory of Everything.

The Kasner solutions to the vacuum Einstein equations via the succeeding phase transitions of the superluminal non-gravitating Higgs field lead to the structure of the core of baryons and next to the atom-like structure of baryons.

Here, within the phenomena characteristic for the core of baryons, we calculated the masses of the spin-1 and spin-3 charmed, strange D resonances with a mass of 2860 MeV. The calculated masses are respectively 2858.5 MeV and 2860.8 MeV (they are very close to the experimental central values) whereas to obtain the exact spins equal to 1 and 3 we need a broadening of masses respectively about ± 5.3 MeV and ±0.9 MeV and it is as well consistent with experimental data. As it follows from experimental data, the broadening of mass for the spin-3 resonance should be lower and the presented here model leads to the same conclusion.

References

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