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The Role of Vacuum Polarization in the Large Hadron Collider

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The Role of Vacuum Polarization in the Large Hadron Collider

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I. Introduction

The CMS collaboration in the experiment at the Large Hadron Collider in 2019 for the first time demonstrated a decrease in the t-quark mass with increasing energy [1]. They are studied the distribution of reaction products in pp collisions with an energy from of 1 TeV to of 13 TeV. It was found the decrease in the of elementary particles mass obtained from data up to an energy of 13 TeV, as well as a decrease in the magnitude of the interaction constants at a confidence level of 95%, depend on the energy at which measurements are made. This effect, explained by vacuum polarization, was indeed observed in experiments in particular, the decrease of the mass of b and c quarks was measured, as well as the decrease of the strong interaction constant [1]. For the first time, CERN in the article [1] the evaluated the role of vacuum polarization in the processes under study at the Large Hadron Collider (Fig.1). In quantum electrodynamics (QED), the instability of vacuum under the influence of relativistic protons in external fields was experimentally established for electric field strengths $E_s = 1.32 \cdot 10^{16} V \cdot cm^{-1}$ (Schwinger's characteristic quantum electro dynamic field) and magnetic field strength $H = 10^{16}$ T, caused by the creation pairs of antiparticle particles in a vacuum (polarization effect of the vacuum) due to which the vacuum itself becomes unstable.

Figure 1: Large Hadron Collider

With the polarization of vacuum and its transformation into matter, the change in vacuum energy w can be represented as the sum:

$$w = w^p + w^e \qquad (1)$$

where w^p is the vacuum polarization, $w^p << E^2 / 8\pi$; w^e is the change in the energy of the substance at the production of particles

$$w^e = eET\varkappa, \quad \varkappa = \frac{e^2E^2T}{4\pi^3}\exp\left(-\pi\frac{m^2}{\hbar E}\right)$$

The creation of particles is the main reason for the change in the energy of the vacuum. The small value of the reverse reaction w^p implies the limitation on the electric field strength for a given time T ($E_s \approx 10^{16}$ V $\cdot$ cm^{-1} is the critical Schwinger's field) [2].

Thus, the new experiments at the Large Hadron Collider (LHC) contradict the Einstein's relativistic theory and the Standard Model. Only recognition of quantum

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vacuum (dark matter) as the third equal participant in the interaction of elementary particles in the LHC (Fig.1) during its polarization during pp- collisions of relativistic protons allows us to explain, in the framework of the new model [2], a decrease in the mass of elementary particles and a decrease in the interaction constants with an increase in the energy of pp collisions from 1 TeV up to 13 TeV. The study of the vacuum polarization phenomenon and the nature of its quantum structure is an actual problem in modern physics. Ignoring this fact often leads to erroneous interpretation of the experimental data.

II. Effects to Talk About the Presence of Quantum Vacuum (Dark Matter) in the Large Hadron Collider

New model represents quantum vacuum (dark matter) as the third full participant of proton collisions in the LHC and whose presence the apologists of the dominant 100 years in the physics of the Einstein's Special Relativity Theory deny [2]. Until recently, it was believed that the use of such an important connection as the unitarity condition (the assertion that the total probability of all elastic and inelastic processes during proton collisions should be equal to unity) allows us to elucidate the spatial picture in the LHC of the proton interaction region and its evolution with a change in energy [3]. However, the results of recent experiments obtained in the LHC, when the proton collision energy reaches 13 TeV, make it possible to doubt the reliability of the unitarity condition when two channels of elastic and inelastic proton collisions are rigidly connected to each other in the probability of particle production events [4]. The recognition of the polarization of quantum vacuum (dark matter) under the action of ultrarelativistic protons and superpower magnetic and electric fields leads to the creation of jets of unstable particles in the LHC and distorts the spatial picture of the proton interaction region adopted in the SM, that is, the third channel is added. Recent discoveries made at the Large Hadron Collider (LHC) include the discovery of the Higgs boson, an increase in the proton interaction cross-section in the energy range $W_p \sim 10 - 100$ GeV, and an increase in the fraction of elastic scattering processes in the energy range $W_p \sim 100$ GeV - 13 TeV, which is a consequence of increased proton stability and also the emission of jets in inelastic processes with a large multiplicity [4]. We consider each of these discoveries from the standpoint of the presence of quantum vacuum (dark matter) and its polarization under the influence of relativistic protons.

a) *The effect of the stability of relativistic protons with increasing energy of their collision in the Large Hadron Collider (LHC)*

The experimental discoveries made recently in the LHC include an increase in the fraction of the processes of elastic scattering of relativistic protons as their collision energy increases, that is, an increase in the proton stability effect. The proton beams collide in the LHC with energies up to 13 TeV in their center of mass system. This energy should exceed the proton's own rest mass by more than four orders of magnitude in magnitude ($m_p \sim 9380000$ MeV). The main goal of research at the collider is to study the forces that control the interaction of particles and clarify their internal structure. Although there are currently no indications of critical deviations from the predictions of the Standard Model (SM), which combines strong and electroweak interactions, a number of experimental facts that need to be explained are observed. This problem is especially evident in the case of strong interactions in the so-called soft hadronic processes. In particular, it is surprising that as the collision energy of relativistic protons increases, the probability of their integrity increases. Such a picture contradicts the notions of classical physics and goes beyond the framework of the SM. The author of the article [4] professor I.V. Dremin concludes that the probability of the survival of two protons with preservation of their integrity, with increasing collision energy, is related to the purely quantum nature of the structure of hadrons with quarks and gluons located inside. They manifest themselves in inelastic processes in the form of newly born ordinary particles and resonances. It is the dynamics of internal fields in the process of elastic collision of protons that should be responsible for the observed increase in the probability of proton survival with increasing energy. The reason for the increase in the probability of proton survival is not yet clear. However, new discoveries make it necessary to reconsider the nature of the resonances and the mechanism for the production of new particles. After Volker Burkert and his colleagues from the Jefferson laboratory found that in the of the proton the pressure could exceed 10^{35} Pascal [5], it would be naive to assume that the maximum energy of the colliding beams of protons achievable in the LHC would be enough to destroy proton.

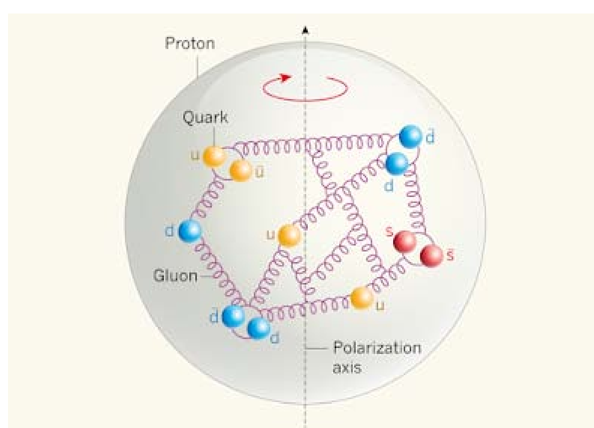

Figure 2: The structure of the proton, quarks and gluons

It can be assumed that the creation of particles in this energy range is associated with resonant phenomena in the quantum vacuum (dark matter) and are irrelevant to the integrity of the protons, that is, all collisions the protons in the LHC, except resonances, are elastic. Volker Burkert conducted a series of experiments on the accelerator CEBAF. After the collision of fast electrons with a mass of liquid hydrogen (a source of protons), the researchers registered the particles arising as a result of their interaction - an electron, a proton, and two photons. This allowed for the first time to measure the pressure in the center of the proton, bombarding the proton with electrons whose energy reached 100 MeV or more, which allowed the electron to penetrate into the structure of the proton [5]. Investigations in particle physics at the CEB-1 collider of the Novosibirsk Budker Institute of Nuclear Physics, Siberian Branch of the Russian Academy of Sciences have confirmed the validity that the electron is a point formation in scales up to 4×10^{-14} cm. Unlike the proton, it does not have an internal structure [6]. At such a small value, the electrons penetrate into the proton. Then the researchers observed the scattering of the photons, comparing their characteristics with information about the proton and the accelerated electron. This scattering gave the scientists a scheme of energies and pulses that made it possible to describe the extreme pressure in the center of the proton. According to modern views the proton consists of three quarks - two u-quarks (upper quarks from the word up) and one d-quark (the bottom quark from the word down), hence the designation uud. The gluons bind quarks in a single particle (Fig. 2). The maximum repulsion between quarks is observed at a distance of 6×10^{-13}m, with the pressure reaching 10^{35} Pascal. This indicator is considered one of the key characteristics of the proton: colossal pressure is directed from the center outward, counteracting the pressure of the outer regions of the particle directed toward the center [5]. The researchers observed the scattering of photons, comparing their characteristics with information about the proton and the accelerated electron. This scattering gave the scientists a scheme of energies and pulses that made it possible to describe the extreme pressure at the center of the proton.

It can be assumed that the creation of new particles in energy range Wp ≈ 10 -100 GeV is associated with the polarization of a quantum vacuum (dark matter) and are irrelevant to the integrity of the protons. The most striking is that the interval of resonant proton energy in the LHC, at which the greatest probability of inelastic collisions of protons and the creation of new particles is observed, corresponds to the energy interval Wp ≈ 10 -100 GeV [4, Fig. 2], however, with increasing energy of relativistic protons, the effect of their stability after collision increases, that is, the probability of conservation of the proton as a single particle increases with increasing collision energy [4]. Noteworthy is the fact that In the alpha-magnetic spectrometer AMS-02, the resonance maximum (peaks) of the total energy spectrum of the secondary electrons and positrons [7, Fig. 16], as well as the maxima of the energy spectra obtained separately for positrons [7, Fig.21] and electrons [7, Fig.22] also correspond to the energy interval Wp≈ 10 -100 GeV. Today scientists at the Large Hadron Collider at CERN think that they may have discovered a new particle, the decay of which gives rise to muon pairs in a narrow peak of the energy of colliding protons strictly defined at 28 GeV, but it is too early to draw final conclusions. Among physicists, this particle causes not only excitement but also an alarm. Unlike the Higgs boson, predicted by the theory of elementary particles in the framework of the simplest version of the Standard Model (SM), the new particle can threaten the CM. The new result - consisting of a mysterious bump in the data at 28 GeV - has been published as a preprint on ArXiv and Roger Barlow's article was published as an on November 13, 2018 (Fig. 3) [8] .

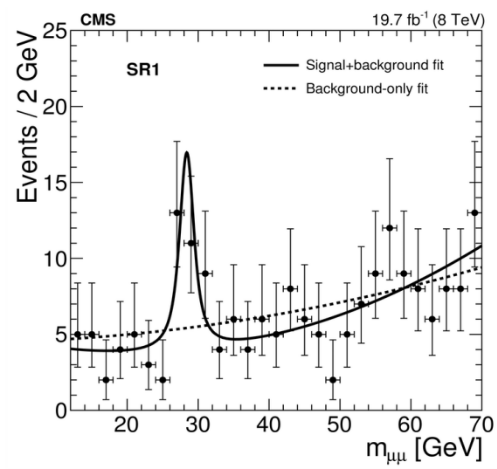

Figure 3: New dark matter particle (fifth interaction) in the LHC

(Peak of energy at 28GeV)

The LHC collaborations have very strict internal review procedures, and we can be sure that the authors have done the amounts correctly when they report "4.2 standard deviation value". This means that the probability of obtaining the peak of this large randomly generated noise in the data, rather than a real particle, is only 0.0013%. In a way, it seems that this should be a real event, not a random noise. If this particle really exists, then it should be outside the standard model, where no one expected it. In most cases, pairs of muons come from different sources from two different events, and not from the decay of a single particle. If you try to calculate the parent mass in such cases, it will spread over a wide range of energies, rather than creating a narrow peak. In the new experiment, the CMS detector detected a large number of pairs of muons and, after analyzing their energies and directions, found that these pairs originate from the decay of one parent particle. You can look at Figure 4 and judge for yourself. Is this a real peak or is it just a statistical wobble due to random scatter of points in the background (dashed curve)? If it is real, it means that some of these pairs of muons are really descended from a large maternal particle the dark matter which decayed, emitting muons - and none of these particles have ever been seen before [8]. I should note that the direct experimental determination of the resonance dependence of the production of elementary particles and antiparticles under the action of the frequency ν of external radiation and relativistic protons in a quantum vacuum (dark matter) is almost completely rejected by modern physics. Following the deceptive logic the modern theory, this dependence is drawn in the form of a monotonously increasing curve, which contradicts the experimental discoveries made recently in the LHC and in near-Earth space using the PAMELA and AMS-2 space spectrometers [9].

b) Higgs boson and the resonant nature of the mass of elementary particles

The discovery in the LHC of heavy Higgs boson resonances (mass 125 GeV), obtained in 2012 with pp collisions at high energies, would seem to confirm the validity the predictions of the Standard Model. The authors of the theoretical works [10] P. Higgs and F. Engler were awarded the Nobel Prize in 2013 for "the theoretical discovery of a mechanism that helps us understand the origin of the masses of subatomic particles and which was rec1ently confirmed by the discovery of a new predicted particle at the Large Hadron Collider." The situation when theoretical predictions appear before their experimental confirmation and wait for almost half a century of their recognition (the Nobel Prize) is really unique. Everything that is now known about the new particle agrees well with its interpretation of the Higgs boson predicted by the theory of elementary particles within the framework of the simplest version of the SM. Within the framework of the SM, it is possible to calculate both the probability of the Higgs boson production in the pp- collisions in the LHC and thereby its decays, and thereby predict the number of expected events. The estimate of the lifetime of the Higgs boson on the basis of experimental data does not contradict the prediction of the Standard Model and is $T \sim 1.6 \cdot 10^{-22}$s. The Higgs boson (H) can decay in many different ways: to photons, to heavy W or Z bosons, to quarks or leptons. What is a boson? Each particle has, as it were, an internal moment of rotation, the spin (this is a quantum mechanical phenomenon). There is a whole and half-integral spin in units of Planck's constant. Particles with spin 1/2 or 3/2 (any half-integral spin) are called fermions. In bosons, the spin is an integer, which leads to fundamental differences in the properties of these particles; in the Higgs boson, the spin is 0 (and this is an integer). The Higgs boson is electrically neutral. The Higgs boson, in contrast to all other vector bosons, is a scalar particle. It is believed that the Higgs field fills the entire universe. But the question arises: "interacting with the Higgs field, all the particles acquire mass, but the Higgs boson from this universal mechanism falls out! This is far from trivial; this ambiguity is fundamental and fraught with extremely serious consequences for SM." In this connection, academic RAS V.A. Rubakov in the article "Higgs Boson" asks the question: "Why do we need a new Higgs field?" and he himself answers: "The short answer is that the symmetries of the theory of elementary particles of the Standard Model forbid elementary particles to have the mass, and a new field breaks these symmetries and ensures the existence the masse of particle" and continues: "In the standard model - the simplest version of the theory (but only in it!) - all the properties of the new field and, correspondingly, of the new boson, except for its mass, are unequivocally predicted again on the basis of symmetry considerations" [11]. Thus, the question of the mass of the Higgs boson is generally deduced from the consideration of the SM. Unfortunately, today the standard model does not have a theory capable of calculating the mass of elementary particles, including the mass of the Higgs boson. Physicists working in the frame of this model stipulate that all their predictions are experimentally confirmed. But this perfect (for lack of something better) model cannot predict even the masses of elementary particles, that is why the SM cannot be considered as a final theory of elementary particles. The standard model (SM) even lacks a mass spectrum calculation algorithm for elementary particles. SM does not have theoretically proved algorithm for spectrum mass computation and no ideas how to do it! SM contains from 20 to 60 arbitrary adjustable parameters (there are different versions of SM) for calculating the mass of particles. All these bear strong resemblance to the situation with Ptolemaic models of Solar system before appearance of Kepler`s laws and Newton s mechanics. These earth-centered models of the planets movement in Solar system had required at first introduction of so called epicycles specially selected for the coordination of theoretical forecasts and observations. L.G.Sapogin's Unitary Quantum Theory (UQT) allows for calculating the mass spectrum of all hitherto known or hypothetical elementary particles up to the Higgs Boson [12]. And also, a solution of the simple scalar version of UQT basic equation for the wave packet allowed producing a theoretical calculation of the elementary electric charge and the fine structure constant of α particle [13]. According to L. Sapogin's UQT, the particles as clots (wave packets) of a real field is governed by the structure-function and can be decomposed into flat sinusoidal waves by means of transformations of the Fourier's series. The structure is here represented as a harmonic amplitude/frequency function (spectral representation). The quantum package becomes classical with increased mass, and quantization the mass in a delicate balance between dispersion and non-linearity. The particle moves according to classical laws of motion, while each packet is governed by quantum laws. L.Sapogin's Unitary Quantum Theory describes elementary particles as clots (wave packets) of a real-world field to be "identified with the quantum vacuum (dark matter)". In proposed our, model of the creation of particles in a quantum vacuum, including the Higgs boson as a result of pp collisions at high energies in the LHC, the mass of the particles is determined by resonances. The physical meaning of this extremely fast oscillatory process is that after an external action on a quantum vacuum, which is a global field of superposition of oscillators with a frequency continuum, a wave packet appears in it, oscillating like a membrane or a string. The frequency of these free vibrations is very high: it is proportional to the rest energy of the particle and is equal to the frequency of the so-called Schrödinger jitter ("zitter-bewegung") $\omega_S = \frac{mc^2}{\hbar\gamma}$, $\gamma = \sqrt{1 - v^2/c^2}$. The calculations show that the envelope wavelength is exactly equal to the de Broglie wavelength, and the dependence of this wavelength on the packet speed is the same! Inside the movement, de Broglie oscillations occur with a frequency $\omega_B = \frac{mv^2}{\hbar\gamma}$ due to dispersion. At low energies $\omega_S >> \omega_B$ and the presence of fast natural vibrations, all quantum phenomena that arise as a result of de Broglie oscillations are not affected. In the case when $v \to c$, frequency $\omega_B \to \omega_S$, $\gamma \to 0$ (resonance frequency ω_r), the phenomenon of energy and resonance growth occurs, which leads to an increase in the oscillating amplitude and an increase in the mass of a quantum object $m_r = \hbar\,\omega_r / c^2$ [14]. The standard graph of the dependence of the particle's mass on its speed is now simply half the amplitude-frequency characteristic of the forced oscillations of a harmonic oscillator with no dissipation, and the mass growth is absolute [14].

III. Role of Quantum Vacuum in the Effects of Reducing the Mass of Elementary Particles, as Well as a Decrease in the Magnitude of the Interaction Constants Found at the Large Hadron Collider in the Reaction Products in PP Collisions with Increasing Energy from 1 TEV to 13 TEV

Since the middle of the last century in quantum electrodynamics (QED), the study of the interaction of high-energy particles revealed resonances that appear as peaks against the general background of the relatively monotonic behavior of the cross sections of their interactions. Resonances were interpreted as a consequence of the presence of quantum levels in the particles themselves and identified in SM as newly born unstable particles. Today, all resonances are classified and described in the framework of the standard model up to the Higgs bosons [4]. But the question arises whether it is correct to interpret all resonances only by the particles themselves. As stated above, quantum vacuum (dark matter) is involved in the products of pp collisions. In this case, the non-gravitational manifestation of dark matter (quantum vacuum) during its polarization and resonance production of electron-positron pairs of elementary particles was detected not only in the LHC, but also in the AMS-2 space detector. The employee Massachusetts Institute of the Technology Yu.V. Galaktionov analyzing the results of studies, notes that "neither electronic nor positron spectra can be described by a power law with a single exponent in the entire energy range under study" [7]. It means the presence of a resonance maximum (peak) in the full energy spectrums of secondary electrons and positrons similar to the birth of decay products of dark matter particles during pp collisions in the Large Hadron Collider. According to L. Sapogin's UQT, the quantum packet becomes a classical particle with an increase in mass and quantization of mass in a delicate balance between dispersion and nonlinearity. In the case when $v \to c$, frequency $\omega_B \to \omega_S$, $\gamma \to 0$ (resonance frequency ω_r), the phenomenon of energy and resonance growth occurs, which leads to an increase in the oscillating amplitude and an increase in the mass of a quantum object [12,14]:

$$m_r = \hbar\,\omega_r / c^2 \qquad (2)$$

where m_r is mass of a quantum object (particle),
ω_r is frequency of the wave function of a quantum object or $\omega = W/\hbar$
W is the particle energy
c is the speed of light $c = 299792458$ m / s
$\hbar = h/(2\pi)$, $\hbar = 1{,}0546 \cdot 10^{-34}$ J / Hz, h is the Planck's constant, $h = 6.6260 \cdot 10^{-34}$ J / Hz

It is of interest to consider the process of changing the mass of an elementary particle depending on the growth of energy (its velocity) to the resonance maximum (peak) of the energy spectrum and after it. In the energy range preceding the resonance, the particle mass growth with speed is close to Einstein's relativistic formula (Fig. 4):

$$m_v = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (3)$$

Where m_o is rest mass and c is the speed of light.

In the framework of the relativistic concepts of modern electrodynamics, dependence (3) is interpreted as the effect of the "increase in mass" m_v of a moving charge to infinity as the speed of charge moves closer to the speed of light. However, an increase in particle mass with velocity occurs for other reasons [14].

In the energy region after resonance, the growth of the mass of an elementary particle stops, and with increasing energy, the mass begins to decrease. This is experimentally established with a probability of 95% at present at the Large Hadron Collider for decay products in pp collisions in the energy range from 1 TeV to 13 TeV.

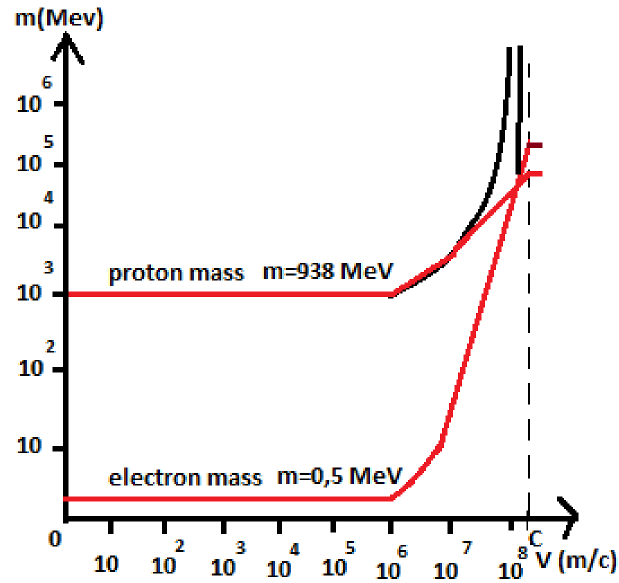

Figure 4: Graph of the dependence of the mass of electrons and protons on velocity, as v → s

The red lines show the resonance dependence of the particle mass, as v → s

The black lines show the relativistic dependence of the particle mass, as v → s.

The effect of a decrease in the constants of fundamental interactions found in the Large Hadron Collider with an increase in the relativistic energy of pp-collisions from 1 TeV to 13 TeV requires additional study, but we can already conclude that it significantly narrow the of the use of magnetic spectrometers in experiments related to measuring the energy spectrum of constant and pulsed beams of ultrarelativistic charged particles and their separation in a constant magnetic field. The reason for this should be sought in the weakening of the interaction between the constant magnetic field of the spectrometer and ultra-relativistic particles, which may lead to incorrect conclusions in the process of data processing. As for the non-invariance of the equations of electrodynamics, it is due to the assumption of the reality of the existence of the medium (dark matter) and taking into account the existence of effects of delayed potentials and deformations of the electric field of moving charges. The complete invariance of the equations of electrodynamics is permissible only in an absolutely empty space of Einstein's STR. I wrote about one such mistake, entitled "The Pamela Effect," in an article "The key to the puzzle "Effect PAMELA"" published in the January issue of the magazine [9]. The weakening of strong interactions in the nuclei of atoms can lead, in particular, to tunneling effects, and the weakening of gravitational interactions can cause levitation.

IV. Conclusion

Thus, the discovery by the CMS Collaboration in an experiment at the Large Hadron Collider in autumn 2019 of a decrease in the mass of elementary particles, as well as a decrease in the constants of fundamental interactions at a confidence level of 95% when studying the distribution of reaction products in pp collisions with an increase in energy from 1 TeV to 13 TeV, opens scientists have new horizons beyond the Standard Model. On the way to improving the theory of quantum electrodynamics (QED) and quantum chromodynamics (QCD), it is necessary, firstly, to introduce the concept of quantum vacuum (dark matter) into physics, secondly, to abandon the postulates of the special theory of Einstein's relativity and the outdated Bohr principle of "complementarity", and thirdly, to reconsider the resonances in the Large Hadron Collider and go beyond tables to those published by the joint Particle Data Group (PDG). To overcome the crisis in theoretical physics, which was pointed out back in 2014 in his article by physicists of the Large Hadron Collider Joseph Likken and Maria Spiropula "Supersymmetry and the crisis in physics", New Physics is needed [15].

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