The Origin of Dark Energy in the New Scenario of Universe Creation and Evolution (revised 2016)

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Abstract

In the work we have advanced another scenario for Universe creation and its evolution, respectively, when the decay of a huge number $\approx 10^{96}$ of Micro-black-holes (micro virtual black holes) as generated due of Quantum fluctuations at Reheating (at 10^{19} GeV ;10^{-29} s) and when themselves till the Confinement epoch (V=2.1GeV) adjust theirs dimensions to that of $e^{+}e^{-}$ pairs (quarks), by radiating **soft free (mass less) photons** and keeping a gravitational charges (mass less gravitons) in event horizon as has recently agreed by Hawking et all (2016). Later at Confinement or Hadrons epoch (V=2GeV), these generate an electrical field (E) that produces a Meissner effect at the interface between normal phase of quarks tubes and the superconducting phase a superconductor magnetic field (B) generated by the soft free photons as color gluons condensate the. The inverse value of the penetration length of B is just $W\pm$ mass at high densities (*QED*) and, the effective non-abelian color gluon mass ($\sim 2GeV$) at QCD.

Also, is proposed a new test for the finally proof of the model as the deduction of the lifetime value of the β^{-} - decay of the free neutron.

1. Introduction

When the decay of a huge number $\cong 10^{96}$ of Micro-black-holes (micro-virtual black holes-μBH) as been produced due of Quantum fluctuations [1a] at Electrweak epoch at 10^{19} GeV ;10^{-29} s that generates during theirs decaying the same number of soft photons [1a],[1c] which condensate later at Confinement into gluons , and when the Micro-black-holes themselves adjust theirs dimensions to that of electrons ($e^{+}e^{-}$) pair and of others leptons (quarks) but keeping the gravitational charge [1a].

At Confinement epoch (V=2GeV) these ex-Micro-black-holes as becoming $e^{+}e^{-}$ - pairs (quarks) which gives an external electrical field (E) [1a], that produces later at the interface between normal phase and the superconducting phase a superconductor magnetic field (B) generated by the free photons color gluons condensate a Meissner effect. The inverse value of the penetration length of B is the effective non-abelian color gluon mass ($\sim 2GeV$) at QCD. Thus, finally, the color gluon condensate components (

B) which equilibrate the quarks electrical field E (that at theirs turn equilibrate the gravitational charge) gives the expansion rate (curvature) of Universe as expressed through the Hubble length from Einstein Equation [1a].

After the discovery of quark (q) jets in 1975 in $e^{+} - e^{-} \to q\bar{q}$ at SLAC, detailed studies in understanding the hadronisation process, and hence the energy-momentum profiles of the quark jets, were initiated in 1977 by Feynman and Field. These $e^{+}e^{-}$ pair's collisions generate either as $\Upsilon\ (94.6GeV) \to 3g$, $(g - gluons)$ near the characteristic energy of electroweak symmetry breaking $\approx 100GeV$, or $q\bar{q}g(\approx fewGeV)$, a $3-jet$ like in PETRA, DESY experiments, for more details see [1b]. These $q\bar{q}g$ flux tube is generated by the electrical field E by Schwinger effect or $e^{+} - e^{-}$ collision, or as at SLAC, that it produces at the interface between normal phase and the superconducting phase, a decay of the superconductor magnetic field (B) generated by the color gluons condensate components like the Meissner effect. The inverse value of the penetration length of B could be equivalent with $W^{\pm}$ bosons at high densities, and the effective color gluon mass existing in nucleons at QCD. The first evidence for the existence of quarks came in 1968, in deep inelastic scattering experiments at the Stanford Linear Accelerator Center (SLAC).

Also, it will be shown that the above masses and numbers of μBH coincide with the numbers of quarks pairs, gluons pairs, electrons pairs, and finally of the new introduced, the polaritons as dark energy after Ionization time, when by tunneling as the **Schwinger effect** with an external electrical field $E \cong E_{cr}$, *when the electric field* E *is induced by* $e^{+} - e^{-}$ *pairs* It was confirmed that the photons decoupling (at Recombination- H atoms forming) when the Thomson scattering with electrons reaction rate $\Gamma_{\gamma} = n_{e}\sigma_{T}$ becomes smaller than the expansion rate, the photons do not scatter any more, theirs distribution freezes and red shifts (z) with the expansion. The recombination it was reconfirmed to occur at $\approx 3000K$, $z \approx 1100$ at CMBR time.

2. How determine μBH particles production the timeline of Universe

First of all, I present some of known data. Thus, in [1a] it is therefore assumed, that "potential energy" caused by gravitation and "kinetic energy" caused by expansion of the Universe are equal to each other (using the relations $R_U = ct$ and $E_U = M_U c^2$):

$$\frac{GM_U^2}{R} = M_U c^2 \to G = \frac{c^5 t}{E_U} \to G = \frac{R_U^5}{t^4 E_U} \quad ,$$

$R_U = 1.6 \times 10^{26} [m]$, the radius of Universe; $t = 5 \times 10^{17} s$, the age of the Universe;

$M_U = 2.2 \times 10^{53} kg$, the mass of the Universe. The Planck mass $m_P = \left(\frac{\hbar c}{G} \right)^{1/2}$; the Planck length $L_P = \left(\frac{\hbar G}{c^3} \right)^{1/2}$; the Planck time $t_P = \left(\frac{\hbar G}{c^5} \right)^{1/2}$.

In fact as already noted [23] from [1b], a Planck mass particle decays via the

Bekenstein radiation within a Planck time $10^{-42}s$, see below.

In Inflation models [2], the scale leaving the horizon at a given epoch is directly related to the number $N(\varphi)$ of e-folds of slow-roll inflation that occur after the epoch of horizon exit. Indeed, since H -the Hubble length is slowly varying, we have $d\ln k = d(\ln(aH)) \cong d\ln a = \frac{\dot{a}dt}{a} = Hdt$. From the definition Eq. (38) of [2] this gives $d\ln k = -dN(\varphi)$ as of eq.(46) from [2a], and therefore $\ln(k_{end}/k) = N(\varphi)$, or, $k_{end} = ke^{N}[m]$ where k_{end} is the scale leaving the horizon at the end of slow-roll inflation, or usually $k^{-1} << k_{end}^{-1}[m]$, the correct equation being $k = k_{end}e^{N}[m^{-1}]$. When the wavelength $(k^{-1}[m])$ is large compared to the Hubble length $(H^{-1}[m])$, the distance that light can travel in a Hubble time becomes small compared to the wavelength, and hence all motion is very slow and the pattern is essentially frozen in.

In this new scenario of Universe evolution are reproduced of the known data.

Also, along the entire Universe dynamics is verified the Einstein formula $E = mc^2$, or when all the created photons transform in mass of the particles.

Since, the FLRW metric of the universe must be of the form $ds^2 = a(t)^2 ds_3^2 - c^2dt^2$ where ds_3^2 is a three-dimensional metric that must be one of **(a)** flat space, **(b)** a sphere of constant positive curvature or **(c)** a hyperbolic space with constant negative curvature, or for small commoving time $dt = \frac{1}{aHc}$, we can consider the distance as $L = ds \cong a = a_{end}$, so the volume is given by:

$$V_{matter} = (a)^4 \frac{1}{c}[m^3 s]$$

In other words,this model of particle creation by trans-Planckian physics results in a significant part of the present total energy density of matter in the Universe being contained in gravitons with energies M_P that is not compatible with the observed behaviour of $a(t)$.

A second example is de Sitter space which contains an event horizon. In this case the temperature T is proportional to the Hubble parameter H, i.e. $T \propto H$, such a conclusion being used by author in [2] to calculate the evolution of Universe.

To estimate the horizon entry we use some derivations done in [2].

During Universe evolution [2a], the horizon leave is when $a_{leave} = k_{leave}/H_{leave} = 1$, $k_{leave}^{-1} = H_{leave}^{-1} = 10^{-27}[m]$, $t_{leave} = H_{leave}^{-1}/c = 3.3\times 10^{-36}s$ at the *Electroweak epoch*

Here, the Hubble constant is defined as

The resulting equations are

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G}{3}\rho + \frac{\Lambda c^2}{3}$$

$$\left(\frac{\dot{a}}{a}\right)^2 = -\frac{8\pi G}{c^2}p + \Lambda c^2$$

In Newtonian interpretation, the Friedmann equations are equivalent to this pair of equations:

$$\frac{\dot{a}^2}{2} = \frac{G\frac{4\pi a^3}{3}\rho}{a}$$

$\rho\,[kg/m^3]$; energy density $p = -\rho c^2$

If we divide with a^2 we obtain for *outside* the object (BH, Universe, planets, stars etc.)

$$\frac{\dot{a}^2}{2a^2} = H^2[s^{-2}] = \frac{GM}{a^3} \Rightarrow \frac{GE}{c^2 a^3} \to \frac{GE}{c^4 a^3} = \frac{G}{c^4 a^3}\cdot n_g \cdot \varepsilon_g [m^{-2}]; \quad (1)$$

, where: $n_g = E/\varepsilon_g$; $n_{at-merging} = \frac{n_g}{\left(\varepsilon_P/\varepsilon_g\right)}$; $M = \frac{4\pi a^3}{3}\rho$; $E = Mc^2$; $M = n_{\mu BH} m_{\mu BH}$;

$R = H^{-1}$.

Or, for *inside* of these objects:

$$\frac{\dot{a}^2}{2a^2} = \frac{G\frac{4\pi a^3}{3}\rho}{a^3}[s^{-2}] \to \frac{4\pi G\rho}{3c^2} = \frac{4\pi G\frac{M_U}{n_{at-merging}\cdot l_C^3}}{3c^2}[m^{-2}] \qquad (2)$$

During Universe evolution (*Electroweak epoch*) due of the quantum fluctuations [2a] a huge number of the micro-black holes as Planck particles n_P are generated, $m_{\mu BH} = m_P$; the graviton energy being at horizon leave ; $\varepsilon_g = \hbar c/a_{end} = 2\times 10^{-26}J$; when $a_{leave} = k_{leave}/H_{leave} = 1$, $M_U = 2.2\times 10^{53}kg$;
$\lambda_C = \hbar c/m_{\mu BH}c^2$; $n_{\mu BH} \approx 1/H_{-1}^3 \cong n_P$, $n_P = E_U/\varepsilon_P = 10^{70}J/10^9 J$ with $m_P = 1.7\times 10^9 J \to 10^{19}GeV$, it results with $k_{leave}^{-1} = H_{leave}^{-1} = 10^{-27}[m]$ by iteration for $N = 16.2$; in eq. (2); $k_{end} = 9.2\times 10^{20}[m^{-1}]$; $H^{-1} = 10^{-20}[m]$; $t = 3.3\times 10^{-29}s$;
$R = 2.7\times 10^{-18}[m]$; $l_C = l_P = 1.7\times 10^{-35}[m]$; $a_{EW} = 0.92$; where $n_g = \frac{\varepsilon_P}{\varepsilon_g}\cdot n_P \to 10^{96}$ as a “fix” number of gravitons escaped (an inverse process of a black-hole) from micro-blacks holes created in Universe as the Planck particles, and which deforms the spacetime.

The number of gravitons is $n_g = \frac{10^{70}J}{10^9 J}\cdot\frac{\varepsilon_P}{10^{-26}/a_{EWl}} = 10^{96}$.

The necessary volume is $V_{necessary} = n_g \cdot \lambda_C^3 = 10^{-9}m^3$, and the available volume being $V_{available} = a_{end}^3 = 0.7m^3$

To mention that only this data set match the model.

Electroweak symmetry breaking-quarks epoch

The μBH particles decay to QGP $m_{QGP} = 2.1\times 10^{-22} kg \to 1.2\times 10^{5} GeV$, or $\varepsilon_{\mu BH} = 10^{19}/a_{end-ee} = 1.2\times 10^{5} GeV \to 1.9\times 10^{-5} J$, $k_{end} = k_{leave}e^{-N}$; $k_{end}^{-1} = 1.2\times 10^{-21}[m]$, $a_{end\_QGP} = 8.3\times 10^{13}$, $\lambda_{C-ee} = 1.6\times 10^{-21}[m]$, with eq. (2) $R = 5.3\times 10^{-8} m$, and $H_{end}^{-1} = 10^{-7}[m]$, $t_{end} = H_{end}^{-1}/c = 3.3\times 10^{-16} s$, $H_{leae}^{-1} = k_{laeve}^{-1} = 10^{-27}[m]$ we found $N = 14$ to match the iterations cycle: $m_g \to \hbar\nu \to k_B T \to \varepsilon \to R \to H_{end}^{-1} \to a_{end} \to N$.

The number of gravitons that has been released following μBHs merging is only $n_{at-merging} = \dfrac{n_g}{\left(\varepsilon_{\mu BH}/10^{-26}\right)} = \dfrac{10^{96}}{\left(1.9\times 10^{-5}/10^{-26}\right)} \cong 5.2\times 10^{74}$, and these generate the curvature radius of the object R .

To mention that only this dataset match the model.

Another proof-the light bending by Earth

The number of graviton in case of Earth is $n_g = U/10^{-26} = 3.2\times 10^{58}$;

$$U = \frac{GM_{Earth}^{2}}{R_{Earth}} = 3.2\times 10^{32} J$$

The number of gravitons that has been released following μBHs (nucleons) merging is only $n_{at-merging} = \dfrac{n_g}{\left(\varepsilon_{\mu BH}/10^{-26}\right)} = \dfrac{3.2\times 10^{58}}{\left(3.6\times 10^{-10}/10^{-26}\right)} \cong 8.8\times 10^{41}$, and that generate the curvature radius of the object ($\cong r_{Schw}$).

Now, the horizon-entry is when the wave length $k_{end} = k_{leave}e^{-N}$; $k_{end} = 31[m^{-1}]$,; the scale factor arrives at $a_{end} = k_{end}/H_{end}$, the frequency is $\upsilon = c/k_{end}^{-1} = 9.3\times 10^{9} Hz$, and the Compton length $\lambda_{C-g0} = \hbar/m_{nucleon\_BH}c = 8.2\times 10^{-17}[m]$, for $\varepsilon_{nucleons} \cong 10^{-10} J$ it results $\varepsilon_P = \varepsilon_{\mu BH} = \varepsilon_{nucleon}/a_{end} = 10^{-10}/a_{end} = 3.6\times 10^{-10} \to 2.2 GeV$; it results $a_{end\_BH} \cong 1$, and from eq. (2) $H_{end}^{-1} \cong r_{Sch} \cong 8.8\times 10^{-3}[m]$, $t_{end} = H_{end}^{-1}/c = 2.9\times 10^{-11} s$, we found $N = 35.7$ to match the iterations cycle:

$m_g \to \hbar\nu \to k_B T \to \varepsilon \to R \to H_{end}^{-1} \to a_{end} \to N$.

At BHs merging, the curvature radius *R* from eq. (2) *with the* number of merging nucleons during which release gravitons as $n_{at-merging}$, $R = H_{end}^{-1} = 5.3\times 10^{-3}[m] \cong r_{Sch}$.

The gravitons release from Earth as a gravitational wave

Therefore, the new horizon leave as gravitational wave (GW) is just when the gravitons *escape from the* Schwarzschild radius (the Universe is a viewed as an inverse big black hole) : $a_{leave} = k_{leave}/H_{leave} = 1$, or $k_{leave}^{-1} = H_{leave}^{-1} = r_{Schw} = 7.4\times 10^{-3}[m]$.

Now, the new horizon-entry is when the wave length $k_{end} = k_{leave}e^{-N}$; $k_{end} = 8\times 10^{-4}[m^{-1}]$, $k_{end}^{-1} = 1.2\times 10^{3}[m]$; and the scale arrives factor at $a_{end} = k_{end}/H_{end}$

, the Hubble length with Compton length $\lambda_{C-GW} = \hbar/m_{g\_GW}c = 16[m]$; from eq. (1) $H_{end}^{-1} = R = 6.5\times 10^{6}[m]$; it results $a_{end\_GW} = 5.3\times 10^{3}$, $t_{end} = H_{end}^{-1}/c = 0.02s$, we found $N = 12$ to match the iterations cycle: $m_g \to \hbar\nu \to k_B T \to \varepsilon \to R \to H_{end}^{-1} \to a_{end} \to N$. The energy of the graviton becomes at an eventually detector (like LIGO) with the above value at merging $\varepsilon_{g\,GW} = \dfrac{\varepsilon_{gBH}}{a_{end\_GW}} = \dfrac{10^{-23}}{6.3\times 10^{17}} = 1.9\times 10^{-27}[J] \to 1.1\times 10^{-17}GeV$, and the frequency is $\upsilon = c/k_{end}^{-1} = 2.4\times 10^{5}Hz$, the mass is $m_{g\_GW} = 2\times 10^{-44}kg$; the number of particles released as the gravitational wave (like the photons of the light wave) remains equally with the above value $n_g = 5.\times 10^{67}$, the total energy initially released is $\mathrm{E}_{GW} = E_{mBH} = \varepsilon_g \cdot n_g = M_{Earth}c^2 = 5\times 10^{41}[J]$, and the curvature radius it results from eq.(1) with the integral (which the starts at the outside of the r_{Schw}) graviton energy with n_g, and with $a_{end} = a_{end\_GW}$, as $R_{Earth} = 6.5\times 10^{6}[m]$.

The strain at Earth surface

Now, based on eq. (1) we can derive for the G-wave effect in the deformation (strain) of the space-time between Earth and a detector site by using the gravitational pressure due of gravity charges on the area of Schwarzschild radius r_{Schw}, we have:

$$\left(\frac{r_{Schw}}{R}\right)^2 = \frac{4\pi}{3}\frac{G\cdot\varepsilon_g\cdot n_g\cdot r_{Schw}^2}{c^4\cdot a_{end\_GW}^3} = 1.24\times 10^{-18}$$

Separately,

$$r_{Schw} = \frac{2G\cdot M_{Earth}}{c^2} = 8.86\times 10^{-3}[m]$$, we have

$$\frac{r_{Schw}^2}{R_{Earth}^2} = 1.34\times 10^{-18} \to r_{Schw}/R_{Earth} = 1.1\times 10^{-9}$$

, so, in both cases the strain is around $\theta = r_{Schw}/R \cong 1.1\times 10^{-9}$, that is near equally with strain as light bending.

The average magnitude of the electric field (negative charge) in the event horizon of a micro-black-hole is like that of the model electron given in [7], and where the inside "trapped" photon is similar with the "absorbed" photon from thermal energy V in case of μBH particle, or in other words the electron is a decaying μBH particle, see below equation (4).

$$\langle E\rangle = \sqrt{\frac{6\hbar c}{\pi\varepsilon_0\lambda^4}}$$

, it results $\langle E\rangle = 2.9\times 10^{50}[N/C]$, for μBH particle of $\lambda_C = 1.6\times 10^{-29}[m]$ and where the gravity charge formally corresponds as $\hbar c \leftrightarrow e^2$

2.1 The μBH dark particles production end

With $\varepsilon_{dark} = 10^{19}/a_{end\_dark} = 7.7\times 10^{-10} GeV = 1.2\times 10^{-19} J$ *as pure gravity particles*, and horizon-entry is when $k_{end} = k_{leave} e^{-N}$; $k_{end}^{-1} = 7.7\times 10^{-8}[m]$, $a_{end\_dark} = 1.3\times 10^{28}$, from eq. (2) $H_{end}^{-1} = 10^{21}[m]$, and the curvature *radius* results $R = 1.2\times 10^{21}[m]$, $t_{end} = H_{end}^{-1}/c \cong R/c = 3.3\times 10^{12} s$, with $H_{leae}^{-1} = k_{laeve}^{-1} = 10^{-27}[m]$ we found $N = 45.8$ to match the iterations cycle: $m_g \to \hbar\nu \to k_B T \to \varepsilon \to R \to H_{end}^{-1} \to a_{end} \to N$.

$T = 9\times 10^3$, $\lambda_{C\_dark} = 2.4\times 10^{-7}[m]$, $\upsilon = c/k_{end}^{-1} = 3.8\times 10^{15} Hz$

The number of gravitons that has been released following μBHs merging is only $n_{at-merging} = \dfrac{n_g}{\left(\varepsilon_{\mu BH}/10^{-26}\right)} = \dfrac{10^{96}}{\left(1.2\times 10^{-19}/10^{-26}\right)} \cong 8\times 10^{88}$, and these generate the curvature radius of the object R.

The necessary volume is $V_{necessary} = n_g \cdot \lambda_C^3 = 10^{69} m^3$, and the available volume being $V_{available} = a_{end}^3 = 10^{84} m^3$

To mention that only this data set match the model.

2.2 The Confinement into nucleons

In the dual-superconductor ($E \leftrightarrow B$) picture for the QCD vacuum, the squeezing of the -electric flux (E) between quarks (as decayed from μBH particles)is realized by the dual Meissner effect, as the result of condensation(as a solenoidal electric current) of **soft photons** as color gluons (bosons) radiated by μBH particles, which is the dual version of the electric charge as the Cooper pair. The order parameter is the vacuum expectation value of the creation operator of gluons (like a condensate under a critical temperature T_c !), such as $e\bar{e}$ for Cooper pairing of electrons in superconductors. The color confinement is based on the analogy between the superconductor and the QCD vacuum. In the superconductor, magnetic field is excluded due to the Meissner effect, which is caused by Cooper-pair condensation. As the result, the magnetic flux is squeezed like the Abrikosov vortex in the type II superconductor [22]. On the other hand, the color-electric flux is excluded in the QCD vacuum, and therefore the squeezed color-flux tube is formed between color sources. Thus, these two systems are quite similar, and can be regarded as the dual version each other. The color-electric field is then excluded in the QCD vacuum through the dual Meissner effect, and is squeezed between color sources to form the hadron flux tube.

Therefore, in case of superconductors an external magnetic flux decreases exponentially into the superconductor, penetrating a distance of the order λ . This distance is called the London penetration depth. In a dual superconductor the roles of magnetic and electric fields are exchanged and the Meissner effect tries to expel electric field lines. Quarks and antiquarks carry opposite color charges, and for a quark–antiquark pair the 'electric' field lines run from the quark to the antiquark. If the quark–antiquark pair is immersed in a dual superconductor, then the electric field lines get compressed to a flux tube. The

energy associated to the tube is proportional to its length, and the potential energy of the quark–antiquark is proportional to their separation.
As resulting from [1a] this Lorenz force appears to be necessary in order to equilibrate the gravity charges (gravitons) embedded in the quarks viewed as ex-micro-black-holes, and these gravitons themselves "deforms" the space-time following Einstein-Friedman equation.
So, in this paper we will continue to follow the development of references [8a; 8b; 23a; 23b], especially, as regarding the single flux-tube solution in the dual Ginzburg-Landau (DGL) theory.

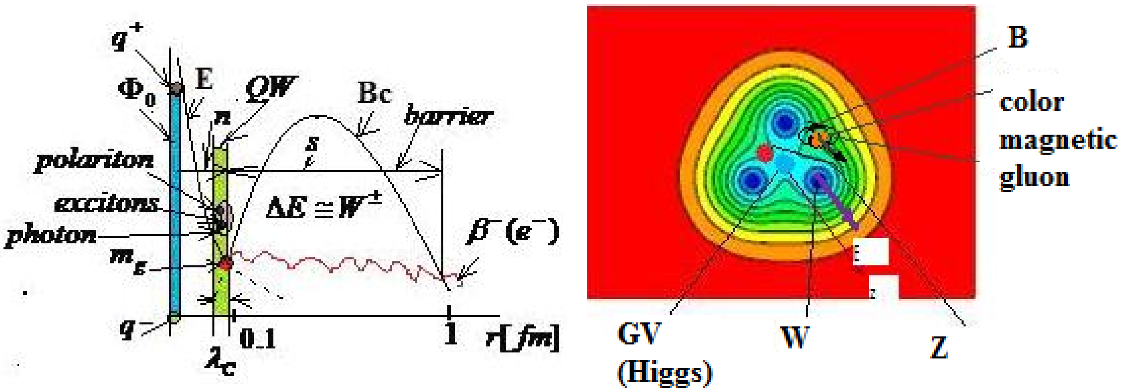

Figure 1.a. The mass generation by dual Meissner effect, the β decay for a free neutron and, the generation of polaritons assimilated with dark matter particles: n -normal vacuum, s -superconductor, QW -quantum well.

At Confinement we have for the vortex potential $3\times q\bar{q}g$ as from [8a],
$V = \varepsilon = \lambda_C^{-1} = 80GeV$ **, it results with eq. (1a;1.b)**
$E = 1.1\times 10^{28}[N/C]$, $B = E/c = 3.7\times 10^{19}[T]$ **.**

Hadrons, along with the valence quarks (q_v) (white) that contribute to their quantum numbers, contain virtual quark–antiquark $(q\bar{q})$ pairs known as *sea quarks* (q_s), see figure 1.b. Sea quarks ($R\bar{R}$) form when a gluon of the hadron's color field splits; this process also works in reverse in that the annihilation of two sea quarks produces a gluon. Free particles have a color charge of zero: baryons are composed of three quarks, but the individual quarks can have red (R), green (G), or blue (B) charges, or negatives.

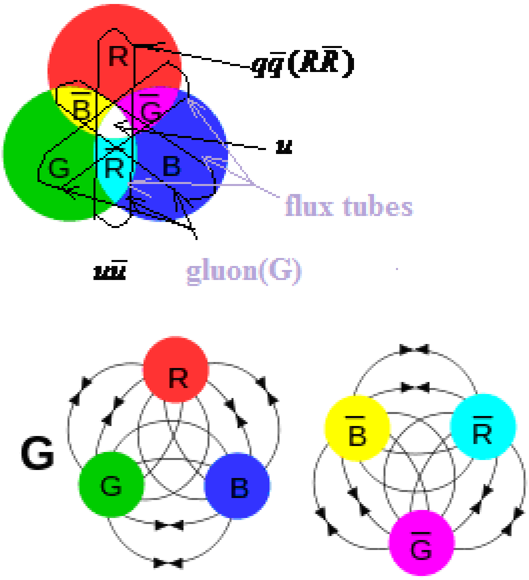

Fig.1.b. Fields due to color charges as in sea quarks ($q\bar{q}(R\bar{R})$) of valence quarks (u), (**G** is the gluon field strength tensor). These are "colorless" combinations. **Top:** Color charge has "ternary neutral states" as well as binary neutrality (analogous to electric charge).

The application of DGL theory to the quark-gluon-plasma (QGP) physics in the ultrarelativistic heavy-ion collisions, or in the early universe, where, a new scenario of the QGP formation via the annihilation of color-electric flux tubes based on the attractive force between them is proposed in [22]. The QGP phase is characterized as the deconfinement and the chiral-symmetry restoration.

There, for the same flux tubes with opposite flux direction (e.g. $R-\bar{R}$ and $\bar{R}-R$), one finds $Q_1 = -Q_2$ i.e. $Q_1Q_2 = -e^2/3$, so that these flux tubes are attracted each other. It should be noted that they would be annihilated into dynamical gluons in this case.

For the different flux tubes satisfying $Q_1Q_2 < 0$ (e.g. $R-\bar{R}$ and $B-\bar{B}$), one finds $Q_1Q_2 = -e^2/6$, so that these flux tubes are attractive. In this case, they would be unified into a single flux tube (similar to $G-\bar{G}$ flux tube), [8b].

The effect of the potential B is the same as shifting the *effective mass*

$m_*^2c^4 = m_e^2c^4 + qB\hbar c^2(2j+1-\sigma)$ for fermions for each Landau level.

Where, $\lambda_C = \hbar/m_*c = 3.6\times10^{-16}[m]$,

the effective mass is

$$m_* = \sqrt{m_e^2c^4 + qB\hbar c^2}/c^2$$

Or $m_q = 9.2\times10^{-28}kg \to 0.5GeV$

which is just the $q\bar{q}$ string tensions .

With $\varepsilon_{\bar{q}q\_g} = \varepsilon_P/a_{end} = 10^{19}/4.7\times10^{18} = 2.1GeV \to 3.4\times10^{-10}J$ at Confinement, when $k_{end} = k_{leave}e^{-N}$; $k_{end}^{-1} = 2.1\times10^{-9}[m]$, $a_{end\_\bar{q}q-g} = 4.7\times10^{18}$, with eq. (2) $H_{end}^{-1} = 1500[m]$, $R = 1400[m]$; $t_{end} = H_{end}^{-1}/c = 5\times10^{-6}s$, and $H_{leae}^{-1} = k_{laeve}^{-1} = 10^{-27}[m]$ we found

$N = 26.5$ to match the iterations cycle: $m_g \to \hbar\nu \to k_B T \to \varepsilon \to R \to H_{end}^{-1} \to a_{end} \to N$

.

The number of gravitons that has been released following μBHs merging is only

$n_{at-merging} = \frac{n_g}{\left(\varepsilon_{\mu BH}/10^{-26}\right)} = \frac{10^{96}}{\left(3.4\times10^{-10}/10^{-26}\right)} \cong 2.9\times10^{79}$, and these generate the curvature radius of the object R.

To mention that only this data set match the model.

From [2a], we have H_0 -an "external" electro-magnetic field of a dipole created by the pair $u\bar{u}$ (the chromoelectrical colors field)

$$H_0 = E_0 = \frac{d\cdot e}{4\pi\varepsilon_0 r^3} = 8.33\times10^{24}[N/C]$$

,where $r = 0.05 fm$ -is the electrical flux tube radius, $d = 0.48 fm$ -the distance between the two quarks charges, this is in fact equilibrated by the gluons field , and respectively, from eq. (2.a;2.b) at a more deep penetration

$\lambda_{C-qq} = 4.7\times10^{-16} > \lambda_{C-gluon} = 8.6\times10^{-17}[m]$, see below.

Because the magnetic induction of the color magnetic gluons current which is powered by electric field given by a pair of quarks (H_0), $B_{gluon} \geq 2H_0 \equiv H_{c2}$, it has the raw flow consequences squeezing this cromoelectrical flux into a vortex line, followed by forcing an organization into a triangular Abrikosov lattice, see figure 1.

The penetration of B is

$\lambda = \left(\frac{\varepsilon_0 .m.c^2}{n_s .e^2}\right)^{1/2}[m]$, m-gluons mass, n_s-number of gluons per $[m]^3$

$$\Phi_0 = \pi\hbar c/e \to usually \frac{\pi\hbar}{e} = 2.07e-15[Tm^2] \to Js/C$$

From [2a], we have the lower critical field:

$$B(x) = \frac{2\Phi_0}{2\pi\lambda^2}\log\frac{\lambda}{\xi} = \frac{\pi\hbar c}{\pi\lambda^2 c}\log(\kappa) = 10^{15}\left[\frac{J}{Am^2}\right], \quad (2.a)$$

where $\xi = 01114$, and when

near the axis, for $x = 0.116 = \xi$, when the induction is

$B(\xi) = 2\times10^{15}[T] = H_{c1}$, $E = cB = 6\times10^{23}[N/C]$

In the case of a homogeneous potential directed along the z-axis [9], the Einstein stress-energy tensor is:

$T^{00} = T^{11} = T^{22} = -T^{33} = \rho_B = \frac{\varepsilon_0 c^2 B^2}{8\pi}$; $T^{0i} = 0$, where $\rho_B[J/m^3]$-the magnetic energy density.

The equivalence between the Lorenz force energy which squeezes the electrical field $E_{e^\pm}$ is $\varepsilon_L = ec\lambda_C B$, and at the interface between normal and superconducting phase we have

$B \cong E/c$, with $e^{\pm}$ pair giving E as: $k_B T = \hbar\nu = \varepsilon_L = ec\lambda_C \frac{\hbar}{e\lambda_C^2} = c\frac{\hbar}{\hbar}mc = mc^2$, and accounting that the inverse of the penetration length $\lambda \cong \lambda_C$.
Also, the interaction energy at interface $E - B$ is:

$$\varepsilon = \frac{V_{vol}\varepsilon_0 c^2 B^2}{8\pi} = \rho_B V_{vol} = V[J], \qquad (2.b)$$

$V_{vol} = 2\pi\lambda_C\lambda_c(4\lambda_C) \cong 8\pi\lambda_C^3$, at Compton length equally with the penetration length $\lambda_C = \lambda$, that results

$$E^2 = \frac{(V)}{\varepsilon_0(\lambda_C^{e*})^3} \qquad (2.c)$$

With $V = \varepsilon_{gluons}$ as above is obtained $B = E_{q\bar{q}}/c = 1.98\times 10^{15}[T]$, where $E_{q\bar{q}} = 5.9\times 10^{23}$ with eq.
(2.a), that are identically with the above values, **indubitable** meaning that this force creates the spacetime curvature and this is equilibrated by the gravity charge, see below.
With equation (4).

$$\langle E\rangle = \sqrt{\frac{6\hbar c}{\pi\varepsilon_0\lambda^4}}$$

, it results $\langle E\rangle = 3.6\times 10^{23}[N/C]$, for $q\bar{q}$ particle of $\lambda_C = 4.7\times 10^{-16}[m]$, that is near the values calculated before by both methods.

2.3. The electrons production

The μBH particles decay to electrons till $m_{e^+e^-} = 9.3\times 10^{-30}kg \to 0.58MeV$, or
$\varepsilon_{e^+e^-} = 10^{19}/a_{end-ee} = 5.8\times 10^{-4}GeV \to 9.3\times 10^{-14}J$, $k_{end} = k_{leave}e^{-N}$;
$k_{end}^{-1} = 5.8\times 10^{-13}[m]$, $a_{end\_e} = 1.7\times 10^{22}$, $\lambda_{C-ee} = 3.2\times 10^{-13}[m]$, with eq. (2)
$R = 2.2\times 10^9 m$, and $H_{end}^{-1} = 10^{14}[m]$, $t_{end} = H_{end}^{-1}/c = 33s$, $H_{leae}^{-1} = k_{laeve}^{-1} = 10^{-27}[m]$ we found $N = 43.2$ to match the iterations cycle:
$m_g \to \hbar\nu \to k_B T \to \varepsilon \to R \to H_{end}^{-1} \to a_{end} \to N$.
The number of gravitons that has been released following μBHs merging is only

$$n_{at-merging} = \frac{n_g}{\left(\varepsilon_{\mu BH}/10^{-26}\right)} = \frac{10^{96}}{\left(9.3\times 10^{-14}/10^{-26}\right)} \cong 10^{83}$$

, and these generate the curvature radius of the object R.

To mention that only this data set match the model.
b) A strong prove of the model-the free neutron decay

In the following, we will use some results of section 4.1a, but where
$\lambda_C = \hbar/m_* c = 2.3e-18[m]$, the effective mass is

$m_* = 1.44\times 10^{-25}kg \to V = 81GeV \to E = 1.1\times 10^{28}$, the *critical field* being

$$E_c = \frac{m_*^2 c^3}{e\hbar} \cong 3.5\times 10^{28} > E = 1.1\times 10^{28}[N/C];\ B = E/c = 3.7\times 10^{19}[T].$$

From the above section (4.1b), are used the bosons $W^{\pm}$ pairs generated *inside the nucleons* as due of one quark $u\bar{u} \leftrightarrow u$ resultant $\times 3$ flux tubes vortex potential , see figure (1.b), respectively $\varepsilon = mc^2 \cong 81GeV$ - which after the release of an electron that it getting the final beta energy as been equally to the out of barrier turning point after the tunneling, and accounting for the valence nucleons interactions (shell-energy levels). The number of *assaults* of the barrier, like in Gamow theory [20, 21] is $n_a = v_b / R_{inner}$; where the velocity is $v_b \cong (2\varepsilon/m)^{1/2} = 2.3\times 10^8\ m/s$, where, the inner radius of the barrier is $R_{inner} \cong b = 3.5\times 10^{-17}[m]$, see below. For only one of the three vortex-flux tubes ($q\bar{q}g$) we have: $\varepsilon = \hbar eB/m \cong 4\times 10^{-9}[J] \to \cong 25GeV$, with the above (B) which is obtained from eq.(1.a) with the resultant potential $V = 81GeV$, that corresponds to $m_{q\bar{q}} \cong 29GeV$ from 4.1a, the energy of the particle for the first Landau level (as above), and we can see that it results to be equally with $\approx 1/3$ rest mass of the $W^{\pm}$, that resulting $n_a \cong 7.5\times 10^{24}s^{-1}$.

In case of WKB [20], the transmission coefficient is $T = 2\frac{\sqrt{2m|V-Q|}}{\hbar}\Delta r$, and the decay constant $\Gamma = n_a e^{-T}$.

For the thick barrier the transmission coefficient is $T = 2\pi\frac{Qb}{\hbar v} = 2\pi\frac{\sqrt{2mQ}}{\hbar}b$;

, where, the kinetic energy of the particle after the barrier at b is $Q \equiv \frac{1}{2}mv^2$,

$b = d_b/2\pi = 3.5\times 10^{-17}[m]$, see below, that results $T = 63$; and the decay constant

$\Gamma = 3\times 10^{-3}s^{-1} \to \cong 324s$

To “materialize” a virtual $e^+ - e^-$ pair in a constant electric field E the separation d must be sufficiently large $eEd = 2mc^2$

Probability for separation d as a quantum fluctuation

$$P \propto \exp\left(-\frac{d}{\lambda_{Compton}}\right) = \exp\left(-\frac{2m^2c^3}{e\hbar E}\right) = \exp\left(-\frac{2E_{cr}}{E}\right)$$

The emission (transmission through barrier) is sufficient for observation when $E \approx E_{cr}$,

with $Q = 1/2\,mc^2$, results $T = 2\pi\frac{mcb}{\hbar} \cong \frac{2\pi b}{\lambda_C}$, or

$b \cong d_b/2\pi$.

Now, by using the Schwinger effect as in section 2.1 , the number of $W^{\pm}$ pairs produced inside the nucleon (more inside of the only one resultant flux tube , see figures 1.a; 1.b) due of the potential resultant $u\bar{u} \leftrightarrow 3\times vortex(q\bar{q}g)$ of $V = 80GeV$, results as

$R = (E/E_{cr})^2 (c/\lambda^4)(8\pi^3)^{-1} * \exp(-\pi E_{cr}/E)$, the rate per unit volume of pair creation R in a constant and uniform electric field of strength E, *when this electric field E is induced by quarks pairs as ex-Micro-black-holes,* or $E/E_{cr} << 1$, positron charge e, mass m, Compton wave-length $\lambda = \hbar/mc$ and so-called "critical" electric field $E_{cr} = m^2 c^3/e\hbar$, it results $R/s = R/V \times V_{vol} = 2.3 \times 10^{18} s^{-1} \approx n_a$, where $R/V = 2 \times 10^{71} [1/m^3 s]$ and the volume is $V_{vol} \cong (\lambda_C)^3 \cong 1.24 \times 10^{-53} [m^3] \geq V_b$, the penetration length being $\lambda_C = 2.3 \times 10^{-18} [m]$, and for a four-volume of $\lambda_C^4/c \cong 9.5 \times 10^{-80} [m^3 s]$, results as a *permanently rate* $R \cong 10^{-8} W^{\pm}$ *pairs*. To note, that in the previously version of the work [1a], we have used for $V = v.e.v = 247 GeV$, and since with this value it results $B = 3.3 \times 10^{20} [T]$ and the velocity of W bosons resulted to be $v_b = 7.2 \times 10^8 > c = 2.986 \times 10^8$, greater than c, that it was not acceptable, so it renounced to consider an external Higgs field $v.e.v$. Otherwise, if this field existed, that means the Universe it remained at about $R = 0.05[m]$.

Thus, it results a main conclusion of this investigation, namely, that the "interacting" potentials inside the nucleons are that were already established in [8a], respectively $\cong 80 GeV$ around the valence quarks (u, d) which it seems to be "locked" at the electroweak symmetry breaking ($\approx 100 GeV$); that of the Giant Vortex (see the insert in fig. 1.a) at the center of the triangle-the Higgs boson $H = 125 GeV$; and that resulting from interaction of $2\times$ interpairs of flux tubes as been the neutral boson $Z = 90 GeV$. Therefore, in other words is proved that all the time inside the nucleon are *available* $10^{-8} W^{\pm}$ pairs that seems to corresponds to the "weak interaction" coupling constant 10^{-7}, which is absorbed or emitted by the quarks , resulting an e^+, or e^- which help the quarks transformation like $(u \to d)$, respectively $(d \to u)$ for beta-decay. In our understanding, the created electron takes the energy at the *turning point* out of the barrier equally with the electron itself for unbounded neutrons, or that of the binding energy of nucleon in isotope nucleus, when it *passes* the barrier of gluon condensate characterized by an *quantum tunneling* suppression given as: $\exp(-\Delta \mathrm{E} \tau/\hbar) \cong 7.3 \times 10^{-22}$, where, as the lifetime of $W^{\pm}$ being $\tau \cong 3 \times 10^{-25} s$. Here, $\Delta \mathrm{E}$ corresponds to the height of gluon condensate barrier, due of the *phase slip* with $2\pi - \varphi$ and of a Φ_0 energy release as: $\Delta E = c^2 \Phi_0^2 \varepsilon_0 / d_b$; $d_b \cong k\lambda_C = 1.98 \times 10^{-16}$, $k = 85$, where the Compton length is just the penetration length for $W^{\pm}$ pair $\lambda_C = 2.3 \times 10^{-18} [m]$, or in other words just the barrier size, and $\Delta \mathrm{E} = 1.6 \times 10^{-8} [J] \to 100 GeV \approx 3 \times 25 GeV$ as for $\times 3$ sea quarks color flux tubes, see figures 1.a; 1.b. The value of the resulting flux tube it remains as in (4.2.a), respectively of $0.4 GeV$ as the string strength.

Thus, the probability (rate) to produce $W^{\pm} \to e^{\pm}$, into a more simple way- without the external interactions of the neutron (free-not bounded), is given as:

$RV\exp(-\Delta E\tau/\hbar) \cong 1.7\times 10^{-3}s^{-1} \to \tau_{1/2} \cong 582[s] \approx 612s$, that corresponds for *free neutrons decay* (β^{-}) by emission of an electron and an electron antineutrino to become a proton $n^0 \to p^+ + e^- + \bar{\nu}_e$, with half-life of $611s$, and $Q_{\beta^-} = m_e v^2 = 0.5MeV$.

Now, the energy corresponding to E_{cr} is much higher than E, respectively as from eq. (1.a): $\nu = E_{cr}^2\varepsilon_0\left(\lambda^3_{Compton}\right)$, $\lambda_{Compton} = \hbar/mc$; $\nu = \varepsilon = mc^2$ or

$$\nu = \frac{m_W^4 c^6}{e^2\hbar^2}\frac{\hbar^3}{m_W^3 c^3}\frac{4\pi\varepsilon_0}{4\pi} = \frac{m_W c^2\varepsilon_0\hbar c 4\pi}{4\pi e^2} \cong \frac{M}{4\pi\alpha} \to \nu \cong 10\times 80 = 800GeV,$$

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{1}{137}$$

, since $(E_c/E)^2 = \left(\frac{3.5\times 10^{28}}{1.1\times 10^{28}}\right)^2 \cong 10$.

In the classic understanding of β^- disintegration $n \to p + e^- + \bar{\nu}_e$, in ours understanding this occurs when one of the down quarks (d) in the neutron (udd) transforms into an up quark (u) due of interacting with the charge of W^+ boson of the pair $W^\pm$, transforming the neutron into a proton (uud). In mean time the other part of this pair W^- boson decays into an electron and an electron antineutrino $udd \to uud + e^- + \nu_e$. Probable the claimed energy of boson W^- is the same as to be the necessarily energy to traverse the gluonic barrier, when it decays into e^- at the end.

The free neutron decay

Consequently, for the β^- decay process, the energy combines well with the existing one, that releasing an electron which penetrates the barrier:

$d \to u + W^+ + W^- \to u + e^- + \bar{\nu}_e$

$d(-1/3e) + e^+(+3/3e) = u(+2/3e) + e^-(-3/3e)$

, since $W^- \to e^-$, and $W^+ \to e^+$

In case of β^+ decay, it can only happen inside nuclei when the daughter nucleus has a greater *binding energy* (and therefore a lower total energy) than the mother nucleus. The difference between these energies goes into the reaction of converting a proton into a neutron, a positron and a neutrino and into the kinetic energy of these particles.

Thus, an opposite process to the above negative beta decay, β^+ decay of nuclei (only bounded proton) when $p \to n + e^+ + \nu_e$, or $energy + uud + W^+ + W^- \to udd + e^+ + \nu_e$, or, $u(2/3e) + e^-(-3/3e) + energy = d(-1/3e) + e^+(3/3e)$.

For free proton decay an *added energy* it seems to be necessarily to reduce the barrier width to $d_b = 9\times 10^{-17}[m]$, when the production rate is:

$RV\exp(-\Delta E\tau/\hbar) \cong 7\times 10^{-29}s^{-1} \to \tau_{1/2} \cong 10^{28}[s]$, respectively, an increase to $\Delta E = 3.5\times 10^{-8}[J] \geq 225GeV$ from $\Delta E = 1.6\times 10^{-8}[J] \to 100GeV$, as for the free neutron, or near $\geq v.e.v = 247GeV$, like at LHC when the gluonic "cover" of protons it was "melted (at least 2 gluons)", and the resulted difference $(\cong 225 - 100 = 125GeV)$ being just that of the Higgs boson (a quanta of energy!) which it was, in this spectacular way "released" [8a] as $2g \to 2\gamma$.
In the process of electron capture, one of the orbital electrons, usually from K or L electron shell, is captured by a proton in the nucleus, forming a neutron and an electron neutrino.

$$p + e^{-} \to n + \nu_e$$

About others calculations of beta decay processes of different isotopes, see the author's work [8a].

Conclusions

The decay of ex-Planck particles of number $\approx 10^{96}$ as $e^{+}e^{-}$ pairs which can generate the external electrical field (E) to condensate the free photons resulting from decaying of the Planck particles as gluons of near the number ($\approx 10^{96}$) and together with the gluon components (B) both contribute to produce expansion rates (curvature) of Universe as expressed through the Hubble length from Einstein Equation when the energy density is of the form $\rho \approx B^2 = E^2/c^2$.
Then, the inverse value of B penetration length by E is just the bosons $W^{\pm}$ mass at high densities, respectively, the effective non-abelian color magnetic gluon mass at QCD densities.
The decay of ex-Micro-black-holes of number $\approx 10^{96}$ as $e^{+}e^{-}$ quarks pairs which can generate the external electrical field (E) to condensate the free photons resulting from radiating of the Micro-black-holes as gluons of near the number ($\approx 10^{96}$) and together with the gluon components (B) both contribute to produce expansion rates (curvature) of Universe as expressed through the Hubble length from Einstein Equation when the energy density is of the form $\rho \approx B^2 = E^2/c^2$.
It is confirmed the timeline of Universe.
Then, the inverse value of B penetration length by E is just the bosons $W^{\pm}$ mass at high densities, respectively, the effective non-abelian color magnetic gluon mass at QCD densities.

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