Fermionic dark matters, dark energy, massive graviton and extended standard model

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Three generations of leptons and quarks correspond to the lepton charges (LCs) in this work. Then, the leptons have the electric charges (ECs) and LCs. The quarks have the ECs, LCs and color charges (CCs).

Three heavy leptons and three heavy quarks are introduced to make the missing third flavor of EC.

These new particles are applied to explain the origins of the astrophysical observations like the ultra-high energy cosmic rays and supernova 1987A antineutrino data.

It is proposed that the gravitational force between dark matters should be much stronger than the gravitational force between the matters and the electromagnetic force between dark matters in order to explain the observed dark matter distributions of the bullet cluster, Abell 1689 cluster and Abell 520 cluster.

New particles can be indirectly seen from the astrophysical observations like the cosmic ray and cosmic gamma ray.

# Standard model (SM)

<table>
<thead>
<tr>
<th>Dark matter force bosons</th>
<th>Weak force bosons</th>
<th>Strong force bosons</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>EC</td>
<td>CC - CC</td>
</tr>
<tr>
<td>? (missing)</td>
<td>+1( W^+ )</td>
<td>8 Gluons (Color Octet)</td>
</tr>
<tr>
<td></td>
<td>0( Z )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-1( W^- )</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dark matters</th>
<th>Leptons</th>
<th>Quarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>EC, LC</td>
<td>EC, LC, CC</td>
</tr>
<tr>
<td>2 x 3(^0) = 2 (?) (missing)</td>
<td>2 x 3(^1) = 6</td>
<td>2 x 3(^2) = 18</td>
</tr>
</tbody>
</table>

EC: Electric charge, LC: Lepton charge, CC: Color charge
1. Standard model (SM),

- lepton (EC, LC)
- quark (EC, LC, CC)

   No Force

   - lepton (LC)
   - lepton (EC)
   - quark (EC)
   - quark (LC)
   - quark (CC)

   No Force

   - strong force (gluons (CC))

no dark matters are assigned.

2. Extended standard model (ESM),

- lepton (EC, LC) → EM force ($\gamma(0,0)$), weak force ($Z/W/Y(EC,LC)$)
- baryon (EC, LC) → EM force ($\gamma(0,0,0)$)
- quark (EC, LC, CC) → EM force ($\gamma(0,0,0)$), strong force ($Z/W/Y(EC,LC,CC)$)
- baston (EC) → EM force ($\gamma(0)$), dark matter force ($Z/W/Y(EC)$) (dark matter)
<table>
<thead>
<tr>
<th>Bastons (EC)</th>
<th>Leptons (EC, LC)</th>
<th>Quarks (EC, LC, CC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>EC</td>
<td>EC</td>
</tr>
<tr>
<td>X1 -2/3 B1</td>
<td>0 ν_e ν_μ ν_τ 2/3 u c t</td>
<td></td>
</tr>
<tr>
<td>X2 -5/3 B2</td>
<td>-1 e μ τ -1/3 d s b</td>
<td></td>
</tr>
<tr>
<td>X3 -8/3 B3</td>
<td>-2 Le Lμ Lτ -4/3 Q1 Q2 Q3</td>
<td></td>
</tr>
<tr>
<td>Total -5</td>
<td>-3</td>
<td>-1</td>
</tr>
</tbody>
</table>

Dark matters:
- X4: -1 = 2/3 -1/3 -4/3
- X5: -3 = 0 -1 -2
- X6: -8/3 ν_τ τ Lτ -2 -3 -1

Each flavor (charge) corresponds to each dimensional axis.

Force carrying bosons: EC, LC, CC = 0, -1, -2

EC, LC, CC Conservations in reactions and decays of particles

The B1, B2 and B3 dark matters interact gravitationally but not electromagnetically with electrons and protons because they do not have the LC and CC charges.
Arbitrary scales

\[ F_g = G \frac{m1m2}{r^2} \]

\[ 10^{36}G_N \]
\[ 10^{12}G_N \]
\[ 10^{-12}G_N \]
\[ g(0) \]
\[ 10^6G_N \]
\[ G_N(\text{dd}) \]
\[ g(0,0,0) \]
\[ G_N \]
\[ G_N(\text{mm}) \]

0 Inflation All particles Stars, Galaxy Present t

\[ k \]
\[ \gamma(0,0) \]
\[ 10^{-48}k \]
\[ \gamma(0) \]

\[ F_c \approx k \frac{EC1EC2}{r^2} \]

Arbitrary scales

\[ F_g(\text{pre}) \] is \( F_g(\text{mm}) \) for a proton with \( G = G_N \).

\( F \) is for a proton-like particle.

\[ 10^{36} \]
\[ 10^{12} \]
\[ 10^4 \]
\[ 10^6 \]

0 Inflation All particles Stars, Galaxy Present t

\[ F_g(\text{dd}) \]
\[ F_g(\text{mm}) \]
\[ F_c(\text{dd}) \]
\[ F_c(\text{mm}) \]

\[ F_c(\text{dm}) \]

\[ 10^{-12} \]
\[ 1 \]

0 0 0 Inflation All particles Stars, Galaxy Present t
Table 1. The relations between particles, Planck energies and gravitation constants are shown. From the relation of \( E_p \geq E_{\text{particle}} = 10^A \text{eV}, \ A \leq 28 \ - \ x/2 \). If \( G = 10^x \ G_N, \ E_p = (\frac{\hbar c}{G})^{0.5} = 10^{x/2} \ 10^{28} \ \text{eV} \). See Fig. 1.

<table>
<thead>
<tr>
<th>Particles [1]</th>
<th>( E_p ) (mm), (eV)</th>
<th>( G = G_N ) (mm) = ( 10^x G_N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gamma )</td>
<td>( \approx 0 )</td>
<td>( \approx \infty ), Big bang</td>
</tr>
<tr>
<td>Graviton</td>
<td>( 10^{-30} )</td>
<td>( 10^{16} G_N )</td>
</tr>
<tr>
<td>( \nu_e )</td>
<td>( 10^{-2} )</td>
<td>( 10^{60} G_N )</td>
</tr>
<tr>
<td>B1</td>
<td>( 10^2 )</td>
<td>( 10^{52} G_N )</td>
</tr>
<tr>
<td>e, u, d</td>
<td>( 10^6 )</td>
<td>( 10^{44} G_N )</td>
</tr>
<tr>
<td>p, n</td>
<td>( 10^{10} )</td>
<td>( 10^{36} G_N, \approx \text{Inflation} )</td>
</tr>
<tr>
<td>W(-1,0), Z(0,0), Baryons, B2</td>
<td>( 10^{11} )</td>
<td>( 10^{34} G_N )</td>
</tr>
<tr>
<td>Le, Nuclei, Atoms, Gas</td>
<td>( 10^{13} )</td>
<td>( 10^{30} G_N )</td>
</tr>
<tr>
<td>All elementary particles</td>
<td>( 10^{22} )</td>
<td>( 10^{12} G_N, \approx 10^5 \text{ years} )</td>
</tr>
<tr>
<td>Stars, Galaxies</td>
<td>( 10^{26} )</td>
<td>( 10^4 G_N, \approx 10^8 \text{ years} )</td>
</tr>
<tr>
<td>Present Planck mass</td>
<td>( 10^{28} )</td>
<td>( G_N, \approx 10^9 \text{ years} )</td>
</tr>
</tbody>
</table>
Standard model

Baryon number (B): baryon +1, anti-baryon: -1, others: 0
Lepton number (L): lepton: +1, anti-lepton: -1, others: 0
B - L symmetry
Quark flavor quantum numbers (S, C, B', T): quark: +1, anti-quark: -1, others: 0
Lepton family numbers (L_e, L_μ, L_τ): lepton: +1, anti-lepton: -1, others: 0

Hyper-charge (Y): \( Y = B + S + C + B' + T \)
Weak charge (\( Y_w \)): \( Y_w = 2(Q - I_3) \)
X-charge (X): \( X = 5(B' - L) - 2Y_w \)
Electric charge (Q); Color charges (red, green, blue)

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Three-dimensional quantized space model

Electric charge (EC); Lepton charge (LC); Color charge (CC)
Bastons (Dark matters) (EC); Leptons (EC,LC); Quarks (EC,LC,CC)
Baryons (EC,LC,-5); Mesons (EC,LC,0)
Charge conservations of EC, LC and CC
Negative and positive charges along the negative time axis and positive time axis, respectively, can be added and subtracted like the scalars on the three-dimensional quantized spaces. The EC, LC and CC charges are different from the vectors like the angular momenta on the three-dimensional quantized spaces.
\gamma(0) \xrightarrow{X} \gamma(0,0) \xrightarrow{X} \gamma(0,0,0) : \text{confinement}

No evaporation of the photons (electromagnetic fields) causes the strong electromagnetic force compared with the weak gravitational force.

\text{Huge evaporation of the gravitons (gravitational fields) causes the weak gravitational force between matters with the small gravitational constant (G_N). G_N(dd) >> G_N(mm) > G_N(dm).}
Within dark matter galaxy cluster, $r < 30$ Mpc
$F_g(dd) - F_c(dd) > 0$ (Attractive force)

Between dark matter galaxy clusters, $r > 30$ Mpc
$F_g(dd) = 0, F_c(dd) > 0$ (Repulsive force)

For the proton-like particle;
$F_g$ : gravitational force strength
$F_c$ : electromagnetic force strength
$F_c(mm) > F_g(dd) > F_g(mm) > F_g(dm) > F_c(dd) > F_c(dm) = 0$

massive gravitons
$g(m) = g(0,0,0)$ for baryonic matters
$g(d) = g(0)$ for dark matters of B1, B2 and B3
$g(m) = 3g(d) > g(d)$ for the rest masses

gravitational force range
$x(dd) = 3x(mm) > x(mm)$
\( M_p \) : Planck mass
\( G_N(mm) = G_N \): Newton’s gravitation constant
\( \rho_{\text{exp}} \): vacuum energy density
\( \rho(QFT) = 2.64 \, (E_{\text{max}})^4 \, \text{erg/cm}^3 \)
\( \rho_{\text{exp}} = 6.29 \, 10^{-9} \, \text{erg/cm}^3 \)

\( E_{\text{max}} \): maximum vacuum oscillation energy
\( E_{\text{min}} \): minimum rest mass energy of a particle
\( E(\nu_e) \): rest mass energy of an electron neutrino
\( E_{\text{max}} = 2E_{\text{min}} = 2E(\nu_e) \), energy unit: eV
From \( \rho(QFT) = \rho_{\text{exp}} \),
\( E(\nu_e) = 3.494 \, 10^{-3} \, \text{eV} \)
Rest mass energy \((E=mc^2)\) calculations of leptons and bastons (dark matters)

\[
F(EC,LC) = -23.24488 + 7.26341 \ |EC| - 1.13858 \ EC^2 \\
+ 0.62683 \ |LC| + 0.22755 \ LC^2
\]

\(E = 11.1950 \ 10^{38+2F}\) for 3 bastons with \(LC = 0\)
\(E = 8.1365 \ 10^{38+2F}\) for leptons \((\nu_e, \nu_\mu, \nu_\tau, e, \mu, \tau)\)
\(E = 0.4498 \ 10^{38+2F}\) for leptons \((L_e, L_\mu, L_\tau)\)

based on \(m(Le) = 1.4 \text{ TeV/c}^2\).
\(E = mc^2\); energy unit: eV

The rest mass energies of the leptons and dark matters are calculated in order to show the energy scales of these particles by using the simple equations.
<table>
<thead>
<tr>
<th>(EC,LC)</th>
<th>$E_{\text{exp}}$ (eV)</th>
<th>$E_{\text{calc}}$ (eV)</th>
<th>(EC,LC)</th>
<th>$E_{\text{exp}}$ (eV)</th>
<th>$E_{\text{calc}}$ (eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\nu_e(0,-2/3)$</td>
<td>?</td>
<td>$2.876 \times 10^{-7}$</td>
<td>$e(-1,-2/3)$</td>
<td>$5.11 \times 10^5$</td>
<td>$5.11 \times 10^5$</td>
</tr>
<tr>
<td>$\nu_\mu(0,-5/3)$</td>
<td>?</td>
<td>$5.947 \times 10^{-5}$</td>
<td>$\mu(-1,-5/3)$</td>
<td>$1.057 \times 10^8$</td>
<td>$1.057 \times 10^8$</td>
</tr>
<tr>
<td>$\nu_\tau(0,-8/3)$</td>
<td>?</td>
<td>$1.000 \times 10^{-1}$</td>
<td>$\tau(-1,-8/3)$</td>
<td>$1.777 \times 10^9$</td>
<td>$1.777 \times 10^9$</td>
</tr>
<tr>
<td>$L_e(-2,-2/3)$</td>
<td>$1.4 \times 10^{12}$</td>
<td>$1.4 \times 10^{12}$</td>
<td>B1(-2/3)</td>
<td>$26.121$</td>
<td>$26.121$</td>
</tr>
<tr>
<td>$L_\mu(-2,-5/3)$</td>
<td>?</td>
<td>$2.896 \times 10^{14}$</td>
<td>B2(-5/3)</td>
<td>$4.27 \times 10^{10}$</td>
<td>$4.27 \times 10^{10}$</td>
</tr>
<tr>
<td>$L_\tau(-2,-8/3)$</td>
<td>?</td>
<td>$4.871 \times 10^{17}$</td>
<td>B3(-8/3)</td>
<td>?</td>
<td>$1.948 \times 10^{15}$</td>
</tr>
</tbody>
</table>

The rest mass energies of the leptons and bastons (dark matters) are calculated and compared with the experimental values.
These data support the existence of heavy leptons like $\text{Le}$, $\text{L}_\mu$, and $\text{L}_\tau$.

A rest mass of $\text{Le}$ could be $1.4 \text{ TeV}/c^2$. 

$\text{Le} \rightarrow e + e + \bar{\nu}_e$

$e/e^+ \text{ annihilation}$

$1.4 \text{ TeV}$

$\text{Le} \text{ decay}$
Cosmic gamma ray spectrum by CALET 5 year measurements from the Galactic center including galactic diffusing background by O. Adriani et al., EPJ Web of Conf. 95, 04056 (2015). These data support the existence of heavy leptons like Le, Lμ and Lt.


A rest mass of Le could be $1.4 \text{ TeV}/c^2$.

These data support the existence of heavy leptons like Le, Lμ and Lτ.
Possible discoveries of 18.7 keV, 3.5 keV and 74.9 keV X-ray peaks support the existence of the new heavy Q1 quark with $\bar{EC} = -4/3$. This can justify the Q1, Q2 and Q3 quarks.
3.5 keV diffuse x-ray emission line from nearby galaxies and galaxy clusters


3.5 keV AGN x-ray absorption line from 2009 Chandra data for Perseus cluster

diffuse cluster x-ray emission and the point-like central Active Galactic Nucleus (AGN) x-ray absorption

3.5 keV AGN x-ray spectrum with Hitomi for Perseus cluster

~18.7 (?): The better statistics could make the better peak shape

Decaying dark matter search with NuSTAR deep sky observation
Possible discoveries of 3.5 keV and 74.9 keV x ray peaks support the existence of the new heavy Q1 quark with EC = -4/3. This can justify the Q1, Q2 and Q3 quarks.
Ultra high energy neutrino measurements

extragalactic gamma rays
Fermi IGRB (2014)

astrophysical neutrinos
IceCube

Particle decay spectra

Le decay

B2

Q1-hadrons

Q2-hadrons


IceCube-Gen2: A Vision for the Future of Neutrino Astronomy in Antarctica
Comparison of cosmic ray spectra resulting from IceTop-73 (IceCube) analysis with other experiments. S. Hussain, arXiv: 1301.6619v1 (2013). Ultra-high energy cosmic ray spectra

The ultra high energy cosmic rays are originated from the decays of the hadrons including the Q1, Q2 and Q3 quarks. The rest mass energies are $E(Q1) = 5 \times 10^{15}$ eV, $E(Q2) = 7 \times 10^{17}$ eV and $E(Q3) = 10^{20}$ eV.
The 42.7(7) GeV peak was identified in the gamma-ray spectrum from the Fermi Large Area Telescope (LAT) in the directions of 16 massive nearby Galaxy Clusters. Y.F. Liang et al., Phys. Rev. D 93, 103525 (2016).

The 42.7 GeV peak is proposed as the B2 annihilation peak.
Dark matter rest mass energy was reported around the energies of 10.6 GeV or 44.8 GeV (~ 42.7 GeV ?).
The curve A fits the observed data well except the 6 BG data. The curve A uses the proposed dark matter mass of B1. It is proposed that the B1 particles come from SN 1987A to the earth. The energies, $E(\nu)$ of the observed neutrinos are reinterpreted as the energies, $E(B1)$ of the B1 dark matters. This supports indirectly that the rest mass energy of the B1 dark matter is 26.12 eV. Here, $t_0$ is the light travel time from SN 1987A to the earth. The equation is taken from the paper by Ehrlich.

Oldest galaxies
\( F_g(\text{dm}) \approx F_c(\text{dd}) \)
\( F_g(\text{mm}) > F_g(\text{dd}) > F_g(\text{dm}) \)

Ultra-diffuse galaxy
NGC1052-DF2 (Observed)

Middle aged galaxies
\( F_g(\text{dm}) > F_c(\text{dd}) \)

Youngest galaxies
\( F_g(\text{dm}) \gg F_c(\text{dd}) \)
\( F_g(\text{dd}) > F_g(\text{mm}) > F_g(\text{dm}) \)

Normal galaxy (Observed)

Gravitational force range
\[ x(\text{dd}) = 3 \times x(\text{mm}) > x(\text{mm}) \]

Observable (weak)

\[ I(\gamma(0)) \gg I(\gamma(0,0)) \]
(Dark matters)

\[ I(\gamma(0,0)) \gg I(\gamma(0)) \]
(Leptons, Hadrons)

\[ I(\gamma(0,0,0)) \gg I(\gamma(0,0)) \]
(Quarks)

\[ \text{Difficult but possible to be observed at LHC} \]

\[ \gamma(0,0): \text{Observable (strong)} \]

\[ \gamma(0,0,0): \text{observable photon} \]

\[ \gamma(0): \text{lepton photon (normal photon)} \]

\[ \gamma(0,0): \text{quark photon (unobservable photon)} \]

\[ \text{Based on the x1x2x3 universe} \]

\[ \gamma(0): \text{baston photon (dark photon)} \]

\[ Z(0) \leftrightarrow Z(0,0) \leftrightarrow Z(0,0,0): \text{Force carrying bosons} \]

\[ \gamma(0) \leftrightarrow \gamma(0,0) \leftrightarrow \gamma(0,0,0): \text{Charge dependent photons} \]

\[ g(0) \leftrightarrow g(0,0) \leftrightarrow g(0,0,0): \text{gravitons} \]
Dark matter

Astrophysical observations

Cosmic gamma rays

High energy cosmic rays

Ultra-high energy cosmic rays

The protons are accelerated by the inelastic Compton scattering with the $\gamma$ rays emitted from the pair annihilations of Q1, Q2 and Q3 hadrons.
$p^U(u(r), u(b), d(g))$

*unobservable*

$\rightarrow$ hadronization

$\rightarrow$ de-hadronization

$\rightarrow$ free quarks

$\alpha_S = 0$

$\rightarrow$ bound quarks

$\alpha_S = 1$

$\rightarrow$ observable

$\rightarrow$ proton

$x1 \times x2 \times x3$

$x1 \times x2 \times x3$

$x4 \times x5 \times x6$

$x7 \times x8 \times x9$

\includegraphics[width=\textwidth]{image.png}

- $\bullet$ : quark
- $\rightarrow$ : $Z(0,0,0), Z(0,0,1), Z(0,0,2), W, Y$ bosons
The lifetime of the $p^u$ state is long enough to show the neutron lifetime anomaly.

The beta ($p^u$) ray could be observed by subtracting the beta ($p$) ray from the total beta ($p+p^u$) ray spectrum.
The pressure distribution inside the proton

\[ \langle \phi(p) \rangle \]

p-p and p-e Inelastic scattering

1. Unobservable (Unob) or Observable (Ob) electromagnetically with the normal photon ($\gamma(0,0)$)
2. Charge conservation of EC, LC and CC
3. •: Quark, Exc: Excitation, Had: Hadronization
From the B1 -e and B1-μ reactions, the cosmic e and μ particles are transferred to the cosmic ν_e and ν_μ neutrinos, respectively. **Cosmic neutrino measurements are needed.**

The enhanced cosmic neutrino observation is the indirect evidence of the B1 and B2 dark matters.
Indirect evidence of B1 dark matters produced at LHC

From the B1 –e and B1-μ reactions, the e and μ particles are transferred to the ν_e and ν_μ neutrinos, respectively. LHC and cosmic neutrino experiments are needed.

The enhanced neutrino observation is the indirect evidence of the B1 and B2 dark matters produced at LHC.
Dark matters (Bastons)

Normal matters (Leptons, Baryons, Mesons)

Unobservable Matters (Quarks)

\[ Z(0) \iff Z(0,0) \iff Z(0,0,0) \]: Force carrying bosons

\[ \gamma(0) \iff \gamma(0,0) \iff \gamma(0,0,0) \]: Charge dependent photons

\[ g(0) \iff g(0,0) \iff g(0,0,0) \]: Gravitons

The dark matters (bastons) do not interact with the normal matters (electrons and protons) by the charge forces.
Gravitational forces through the gravitons of $g(0)$, $g(0,0)$ and $g(0,0,0)$

$Z(0) \longleftrightarrow Z(0,0) \longleftrightarrow Z(0,0,0)$: Force carrying bosons

$\gamma(0) \leftrightarrow X \leftrightarrow \gamma(0,0) \leftrightarrow X \leftrightarrow \gamma(0,0,0)$: Charge dependent photons

$g(0) \leftrightarrow g(0,0) \leftrightarrow g(0,0,0)$: gravitons

The baryons and mesons interact with the $g(0,0,0)$ quark graviton.
Table 2. Energies of the previously known particles are shown as the function of the possible sizes (radius, $x$ (m)) of the particles from the equations of $E = 8.1365 \times 10^{38} x^2$ for the leptons ($\nu_e, \nu_\mu, \nu_\tau, e, \mu, \tau$) and $E = 12.2047 \times 10^{38} x^2$ for the quarks, baryons and mesons based on the measured size and energy of the proton [5].

<table>
<thead>
<tr>
<th>$x$ (m)</th>
<th>$E$ (eV)</th>
<th>particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.768(69) $10^{-16}$</td>
<td>938.27 $10^6$</td>
<td>p</td>
</tr>
<tr>
<td>1.229 $10^{-22}$</td>
<td>$(10^{-4})$</td>
<td>$\nu_e, \nu_\mu, \nu_\tau$</td>
</tr>
<tr>
<td>2.506 $10^{-17}$</td>
<td>0.511 $10^5$</td>
<td>e</td>
</tr>
<tr>
<td>3.604 $10^{-16}$</td>
<td>105.7 $10^5$</td>
<td>$\mu$</td>
</tr>
<tr>
<td>1.478 $10^{-15}$</td>
<td>1.777 $10^9$</td>
<td>$\tau$</td>
</tr>
<tr>
<td>4.434 $10^{-17}$</td>
<td>2.4 $10^6$</td>
<td>u</td>
</tr>
<tr>
<td>6.271 $10^{-17}$</td>
<td>4.8 $10^6$</td>
<td>d</td>
</tr>
<tr>
<td>2.919 $10^{-16}$</td>
<td>104 $10^6$</td>
<td>s</td>
</tr>
<tr>
<td>1.020 $10^{-15}$</td>
<td>1.27 $10^9$</td>
<td>c</td>
</tr>
<tr>
<td>1.855 $10^{-15}$</td>
<td>4.2 $10^9$</td>
<td>b</td>
</tr>
<tr>
<td>1.184 $10^{-14}$</td>
<td>171.2 $10^9$</td>
<td>t</td>
</tr>
<tr>
<td>1.616 $10^{-35}$ (Planck length)</td>
<td>3.1872 $10^{-31}$</td>
<td>graviton, $g(0,0,0)$</td>
</tr>
</tbody>
</table>
The $g(0)$ graviton is the $1\times2\times3$ space quantum. The energy of these $g(0)$ gravitons is defined as the dark energy density ($\rho_g$) is the same as the dark energy density ($\rho_\Lambda$) measured from WMAP.

$N = N_1 - N_2$: number of new space quanta $1\times2\times3$ space expansion if $N > 0$. Accelerated $1\times2\times3$ space expansion if $\frac{dN}{dt} > 0$.

$g(0)$: evaporation

$g(0,0)$: evaporation

$g(0,0,0)$: evaporation

N1 spaces $g(0)$ N2 holes $x_{1\times2\times3}$ $x_{4\times5\times6}$ $x_{7\times8\times9}$
arbitrary scales

\[ N = N_1 - N_2 > 0 \]

N1

N2

N

0

inflation

accelerated expansion

time

x1x2x3 space
\[ E_{\text{max}} = E_{\text{min}} = E(M_p) \]
\[ \rho(\text{QFT}) = 10^{123} \rho_{\text{exp}} \]

\[ E_{\text{max}} = 2E_{\text{min}} = 2E(\nu_e) \]
\[ \rho(\text{QFT}) = \rho_{\text{exp}} \]

- **M\_p**: Planck mass
- **\( G_N(\text{mm}) = G_N \)**: Newton’s gravitation constant
- **\( \rho_{\text{exp}} \)**: vacuum energy density
- **\( \rho(\text{QFT}) \)**: 2.64 \((E_{\text{max}})^4\) erg/cm\(^3\)
- **\( \rho_{\text{exp}} = 6.29 \times 10^{-9} \) erg/cm\(^3\)**

- **\( E_{\text{max}} \)**: maximum vacuum oscillation energy
- **\( E_{\text{min}} \)**: minimum rest mass energy of a particle
- **\( E(\nu_e) \)**: rest mass energy of an electron neutrino

\[ E_{\text{max}} = 2E_{\text{min}} = 2E(\nu_e), \quad \text{energy unit: eV} \]

From \[ \rho(\text{QFT}) = \rho_{\text{exp}} \],

\[ E(\nu_e) = 3.494 \times 10^{-3} \text{ eV} \]
No evaporation of the photons (electromagnetic fields) causes the strong electromagnetic force compared with the weak gravitational force.

Huge evaporation of the gravitons (gravitational fields) causes the weak gravitational force between matters with the small gravitational constant ($G_N$). $G_N(dd) >> G_N(mm) > G_N(dm)$. 

$k(dm) = 0$, $k(mm) >> k(dd)$: Coulomb’s constant

$\gamma(0) \leftrightarrow \gamma(0,0)$: confinement

$\gamma(0)$ : evaporation
Matter universe big bang

The quarks, leptons and dark matters are created through the inflation.

The leptons and dark matters are gravitationaly attracted by the galaxy particles.

The hadrons, leptons, and dark matters form the galaxies.

Note that an anti-matter partner universe big bang should take place in terms of the CP symmetry. The inflation and expansion of the x1x2x3 space are originated from the new spaces created by the evaporated gravitons into the x1x2x3 space and the repulsive electromagnetic force between dark matters corresponding to the dark energy.
Fg = G \frac{m_1 m_2}{r^2}

F_{g\text{(pre)}} is F_{g\text{(mm)}} for a proton with G = G_N.

F is for a proton-like particle.
Table 1. The relations between particles, Planck energies and gravitation constants are shown. From the relation of \( E_p \geq E(\text{particle}) = 10^A \text{ eV}, A \leq 28 - x/2 \). If \( G = 10^x G_N \), \( E_p = \left(\frac{\hbar c}{G}\right)^{0.5} = 10^{-x/2} 10^{28} \text{ eV} \). See Fig. 1.

<table>
<thead>
<tr>
<th>Particles</th>
<th>( E_p(\text{mm}), \text{(eV)} )</th>
<th>( G = G_N(\text{mm}) = 10^x G_N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gamma )</td>
<td>( \approx 0 )</td>
<td>( \approx \infty ), Big bang</td>
</tr>
<tr>
<td>graviton</td>
<td>( 10^{-30} )</td>
<td>( 10^{116} G_N )</td>
</tr>
<tr>
<td>( \nu_e )</td>
<td>( 10^{-2} )</td>
<td>( 10^{60} G_N )</td>
</tr>
<tr>
<td>B1</td>
<td>( 10^2 )</td>
<td>( 10^{52} G_N )</td>
</tr>
<tr>
<td>e, u, d</td>
<td>( 10^6 )</td>
<td>( 10^{44} G_N )</td>
</tr>
<tr>
<td>p, n</td>
<td>( 10^{10} )</td>
<td>( 10^{36} G_N )</td>
</tr>
<tr>
<td>W(-1,0), Z(0,0), Baryons, B2</td>
<td>( 10^{11} )</td>
<td>( 10^{34} G_N )</td>
</tr>
<tr>
<td>Nuclei, Atoms</td>
<td>( 10^{12} )</td>
<td>( 10^{32} G_N )</td>
</tr>
<tr>
<td>Le, Stars, Galaxies</td>
<td>( 10^{13} )</td>
<td>( 10^{30} G_N )</td>
</tr>
<tr>
<td>All elementary particles</td>
<td>( 10^{22} )</td>
<td>( 10^{12} G_N )</td>
</tr>
<tr>
<td>Present Planck mass</td>
<td>( 10^{28} )</td>
<td>( G_N ), Flat space</td>
</tr>
</tbody>
</table>
Because of the huge number \( N \) of the evaporated gravitons, the very small Coulomb’s constant of about \( 10^{-48}k \) and large gravitation constant of \( 10^6 G_N \) are expected for the charged dark matters. Therefore, \( F_c(mm) > F_g(dd) > F_g(mm) > F_g(dm) > F_c(dd) > F_c(dm) = 0 \) for the proton-like particle. The gravitational force strength \( (F_g(mm)) \) between the matters is so weak compared with the electromagnetic force strength \( (F_c(mm)) \) between the matters. Therefore, it is concluded that the Coulomb’s constant is constant because of the photon confinement but the gravitation constant has been changing since the inflation because of the graviton evaporation along with the space evolution. The changing process of the gravitation constant between the matters from \( G_N(mm) \approx 10^{36} G_N \) to \( G_N(mm) = G_N \) happened mostly near the inflation period in Fig. 7. Therefore, during the most of the universe evolution the gravitation constant could be taken as \( G_N(mm) = G_N \). This explanation with the possible numerical values of \( k \) and \( G \) in Fig. 7 is only the example which needs to be further investigated in the future.
The tentative numerical values of $k$ and $G$ in Fig. 7 are added just in order to show that the graviton evaporation and photon confinement can explain the relative force strengths of the electromagnetic interactions and gravitational interactions well. For example, it can be assumed that near the inflation $G_N(\text{mm}) \approx 10^{36}G_N$, and $G_N(\text{dd}) = 10^{-12}G_N$ in Fig. 7. This condition indicates that the matters forms the black holes with the very large Schwarzschild radius because of the large gravitation constant of $G_N(\text{mm}) \approx 10^{36}G_N$. It can be assumed that at the present time, $G_N(\text{mm}) = G_N$, and $G_N(\text{dd}) \approx 10^6G_N$ because of the graviton evaporation in Fig. 7. This condition indicates that the matters forms the black holes with the small Schwarzschild radius because of the small gravitation constant of $G_N(\text{mm}) \approx G_N$. And, it can be assumed that always $k(\text{mm}) = k \approx 10^{48}k(\text{dd})$. 
At the present time, \( F_g(mm) = 8 \times 10^{-37} F_c(mm) \approx 10^{-36} F_c(mm) \) for the proton. \( F_c = F_c(EC) + F_c(LC) + F_c(CC) \approx F_c(EC) = k \frac{E_{1EC}}{r^2} \) because \( k(EC) > k(LC) > k(CC) \) [6,7]. \( F_c(LC) \) plays an important role for the neutrinos with the zero EC charges and non-zero LC charges [6,7]. Here it is assumed that the \( k \) and \( G \) values are similar for the leptons and quarks. Then \( F_c(mm) \approx 10^{36} F_g(mm), F_g(dd) = 10^6 F_g(mm) \) and \( F_c(dd) = 10^{-12} F_g(mm) \) for a proton-like particle in Figs. 2, 3 and 7. This assumption can explain the relation of, at present time, \( F_c(mm) > F_g(dd) > F_g(mm) > F_g(dm) > F_c(dd) > F_c(dm) = 0 \) for the proton-like particle in Figs. 2, 3 and 7. For the B1 dark matter with the rest mass of 26.12 eV/c^2 [1], \( F_g(dd) \approx 10^{-10} F_g(mm) \) and \( F_c(dd) = \frac{4}{9} 10^{-12} F_g(mm) \) where \( F_g(mm) \) is for the proton. Therefore, \( F_g(dd) > F_c(dd) \) for the B1, B2 and B3 dark matters as shown in Fig. 3. This assumption can explain the reason why the gravitational force strength \( (F_g(mm)) \) between the matters is so weak compared with the electromagnetic force strength \( (F_c(mm)) \) between the matters. Therefore, it is concluded that the Coulomb’s constant is constant because of the photon confinement but the gravitation constant has been changing since the inflation because of the graviton evaporation along with the space evolution in Figs. 5-7. It is expected that the changing process of the gravitation constant between the matters from \( G_N(mm) \approx 10^{36} G_N \) to \( G_N(mm) = G_N \) happened mostly near the inflation period in Fig. 7. Therefore, during the most of the universe evolution the gravitation constant could be taken as \( G_N(mm) = G_N \). This explanation with the possible numerical values of \( k \) and \( G \) in Fig. 7 is only the example which needs to be further investigated in the future.
## Complete table of the force carrying bosons in Extended Standard Model (ESM)

<table>
<thead>
<tr>
<th></th>
<th>Dark matter force</th>
<th>Weak force (EC,LC)</th>
<th>Strong force (EC,LC,CC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC</td>
<td>EC</td>
<td>EC</td>
</tr>
<tr>
<td><strong>X1</strong></td>
<td>0</td>
<td>Z(0)</td>
<td>Z(0,0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Z(0,−1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Z(0,−2)</td>
</tr>
<tr>
<td><strong>X2</strong></td>
<td>-1</td>
<td>W(−1)</td>
<td>W(−1,0)</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>W(−1,−2)</td>
</tr>
<tr>
<td><strong>X3</strong></td>
<td>-2</td>
<td>Y(−2)</td>
<td>Y(−2,0)</td>
</tr>
<tr>
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<td></td>
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<td>Y(−2,−2)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-3</td>
<td></td>
<td>-3</td>
</tr>
<tr>
<td></td>
<td>LC</td>
<td></td>
<td>LC</td>
</tr>
<tr>
<td><strong>X4</strong></td>
<td>0</td>
<td>Z(0,0)</td>
<td>Z(0,0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>W(−1,0)</td>
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<tr>
<td></td>
<td></td>
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<td>Y(−2,0)</td>
</tr>
<tr>
<td><strong>X5</strong></td>
<td>-1</td>
<td>Z(0,−1)</td>
<td>Z(0,−1)</td>
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<td></td>
<td></td>
<td></td>
<td>W(−1,−1)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Y(−1,−1)</td>
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<tr>
<td><strong>X6</strong></td>
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<td>Z(0,−2)</td>
<td>Z(0,−2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>W(−1,−2)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-3</td>
<td></td>
<td>-3</td>
</tr>
<tr>
<td></td>
<td>CC</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>X7</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z, W, gluons (SM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z(0,LC), W(−1,LC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z(0,0,CC) (ESM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>X8</strong></td>
<td></td>
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<td></td>
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<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>X9</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z/W/Y(EC,LC,0)</td>
<td></td>
<td>Z/W/Y(EC,LC)</td>
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<tr>
<td></td>
<td>Z/W/Y(EC,0)</td>
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<td>Z/W/Y(EC)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>-3</td>
</tr>
</tbody>
</table>

\[
Z/W/Y(-1,0)CC(-2) = Z/W/Y(-1,0,-2)
\]
<table>
<thead>
<tr>
<th>SM</th>
<th>Leptons, Mesons, Baryons (EC)</th>
<th>Quarks (EC,CC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Range Force (EM Force), Photon</td>
<td>F(EC), QED, $\gamma$</td>
<td></td>
</tr>
<tr>
<td>Short Range Force</td>
<td>Weak Force</td>
<td>Strong Force, QCD, Massless gluons (CC)</td>
</tr>
<tr>
<td>ESM (TQSM)</td>
<td>Bastons (EC) (Dark matters)</td>
<td></td>
</tr>
<tr>
<td>Long Range Force (EM Force), Photon QED</td>
<td>F(EC), Dark photon $\gamma(0)$</td>
<td>F(EC,LC) = F(EC)+F(LC) Unobservable photon $\gamma(0,0,0)$</td>
</tr>
<tr>
<td>Short Range Force</td>
<td>Dark matter force Z/W/Y(EC)</td>
<td></td>
</tr>
<tr>
<td>Massive bosons</td>
<td>Weak force Z/W/Y(EC,LC)</td>
<td>Strong force Z/W/Y(EC,LC,CC)</td>
</tr>
</tbody>
</table>

In SM, the force corresponding to the lepton charges (LC) is not considered.
Each flavor (charge) corresponds to each dimensional axis.

EC: x1
LC: x2
CC: x3

EC: x1x2
LC: x3x4
CC: x5x6

EC: x1x2x3
LC: x4x5x6
CC: x7x8x9

N: 1
1 elementary particle number

(x1x2), (x3x4), (x5x6), (x7x8),

2 - dimensional quantized spaces

N: 2
2^2 = 4
2^3 = 8

(x1x2x3), (x4x5x6), (x7x8x9), (x10,x11,x12),

3 - dimensional quantized spaces

N: 3
3^2 = 9
3^3 = 27

Bastons (EC)
Leptons (EC,LC)
Quarks (EC,LC,CC)
Each flavor (charge) corresponds to each dimensional axis.

EC: x1x2x3x4
LC: x5x6x7x8
CC: x9x10x11x12

Only the 3-dimensional quantized spaces can explain the baston, lepton and quark table.
• Three fermionic B1, B2 and B3 dark matters with the rest mass energies of 26.1, 4.27 $10^{10}$ and 1.9 $10^{15}$ eV are proposed.
• The rest mass energies of the leptons and dark matters are calculated by using the simple equations.
• The ultra high energy cosmic rays and gamma rays are originated from the decays and annihilations of the hadrons including the Q1, Q2 and Q3 quarks with the possible masses of $10^{15-20}$ eV and the heavy leptons.
• SN1987A data are discussed in the relation with the B1 dark matter annihilation.
• The 18.7 keV, 3.5 keV and 74.9 keV x ray peaks observed from the cosmic x-ray background spectra are originated not from the pair annihilations of the dark matters but from the x-ray emission of the Q1 baryon atoms. The presence of the 3.5 keV cosmic X-ray supports the presence of the Q1 quark with the EC of -4e/3.
• The 1.4 TeV peak observed at the cosmic ray is explained by using the rest mass $(1.4 \text{ TeV/c}^2)$ of the Le particle with the EC charge of -2e. These data support the existence of heavy leptons like Le, Lμ and Lτ.
• Neutron lifetime anomaly and strong force coupling constant are explained.
• It is proposed that the EC, LC and CC charges are aligned along the time axes but not along the space axes.