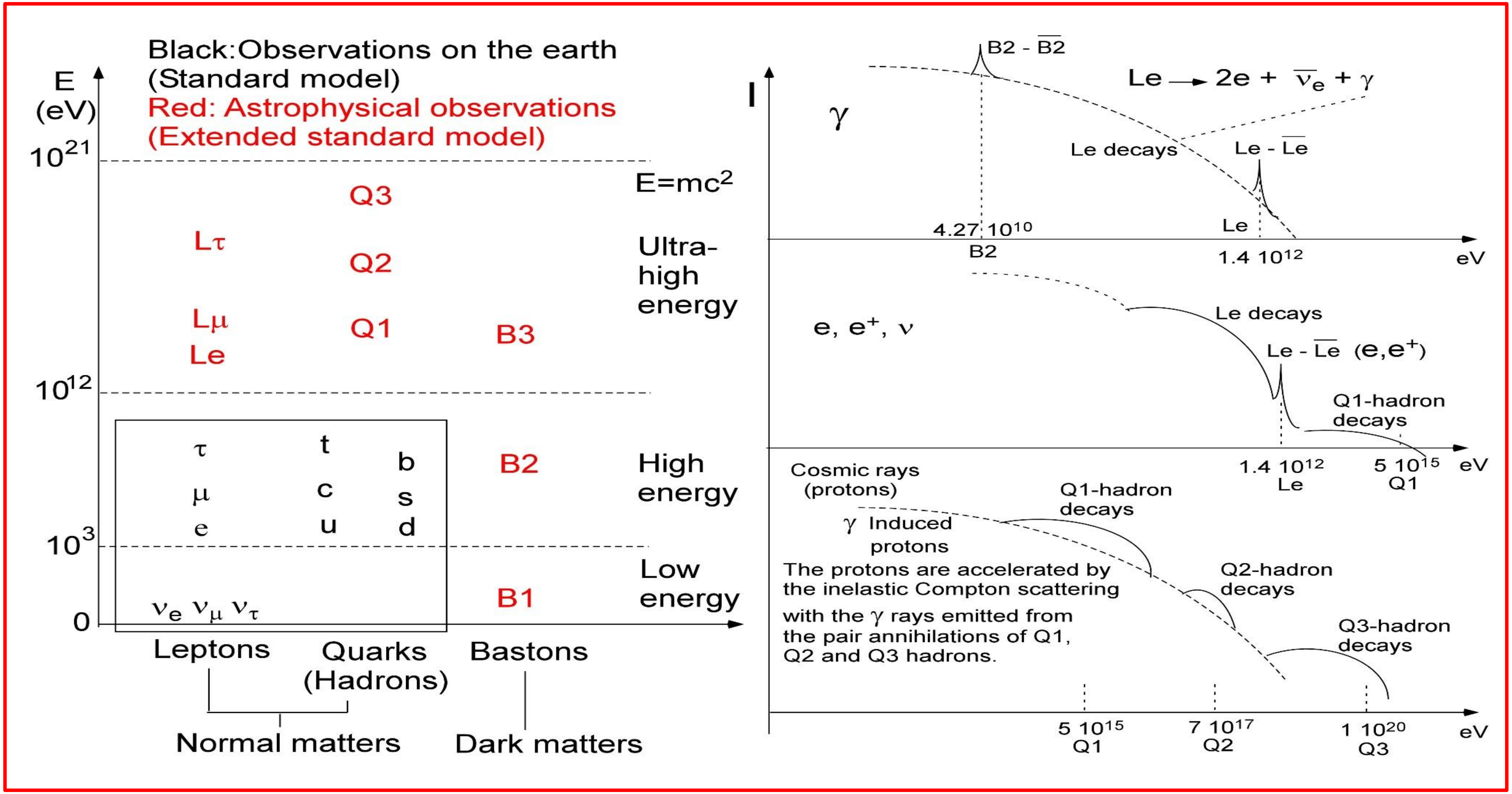
Fermionic dark matters, dark energy, massive graviton and extended standard model



Jae-Kwang Hwang, JJJ Physics Laboratory

- 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.

- 1. J.K. Hwang, www.researchgate.net/publication/320695036 .
- 2. J.K. Hwang, Modern Physics Letters A32, 1730023 (2017).
- 3. J.K. Hwang, www.researchgate.net/publication/313247136 .

Standard model (SM)

Dark matter force bosons	Weak force bosons		Strong force bosons
EC	EC		CC - $\overline{CC}$
? (missing)	+1	W^+	8 Gluons (Color Octet)
	0	Z	
	-1	W^-	

Dark matters	Leptons	Quarks
EC	EC, LC	EC, LC, CC
$2 \times 3^0 = 2$ (?) (missing)	$2 \times 3^1 = 6$	$2 \times 3^2 = 18$

EC: Electric charge, LC: Lepton charge, CC: Color charge

1. Standard model (SM),

lepton(EC,LC) → lepton(LC) → No Force

lepton(EC,LC) → lepton(EC) → EM force (γ), weak force (Z,W^+,W^-(EC))

quark(EC,LC,CC) → quark(EC) → EM force (γ), weak force (Z,W^+,W^-(EC))

quark(EC,LC,CC) → quark(LC) → No Force

quark(EC,LC,CC) → quark(CC) → Strong force (gluons (CC))

no dark matters are assigned.

2. Extended standard model (ESM),

lepton(EC,LC) → EM force (γ(0,0)), weak force (Z/W/Y(EC,LC))

baryon(EC,LC) → EM force (γ(0,0)), weak force (Z/W/Y(EC,LC))

quark(EC,LC,CC) → EM force (γ(0,0,0)), strong force (Z/W/Y(EC,LC,CC))

baston(EC) (dark matter) → EM force (γ(0)), dark matter force (Z/W/Y(EC))

	Bastons (EC)				Leptons(EC,LC)				Quarks(EC,LC,CC)			
	EC				EC				EC			
X1	-2/3	B1			0	ν_e	ν_μ	ν_τ	2/3	u	c	t
X2	-5/3	B2			-1	e	μ	τ	-1/3	d	s	b
X3	-8/3	B3			-2	Le	Lμ	Lτ	-4/3	Q1	Q2	Q3
Total	-5				-3				-1			
					LC				LC			
X4					-2/3	ν_e	e	Le	0	u	d	Q1
X5					-5/3	ν_μ	μ	Lμ	-1	c	s	Q2
X6					-8/3	ν_τ	τ	Lτ	-2	t	b	Q3
Total					-5				-3			
									CC			
X7									-2/3(r)			
X8									-5/3(g)			
X9									-8/3(b)			
Total									-5			

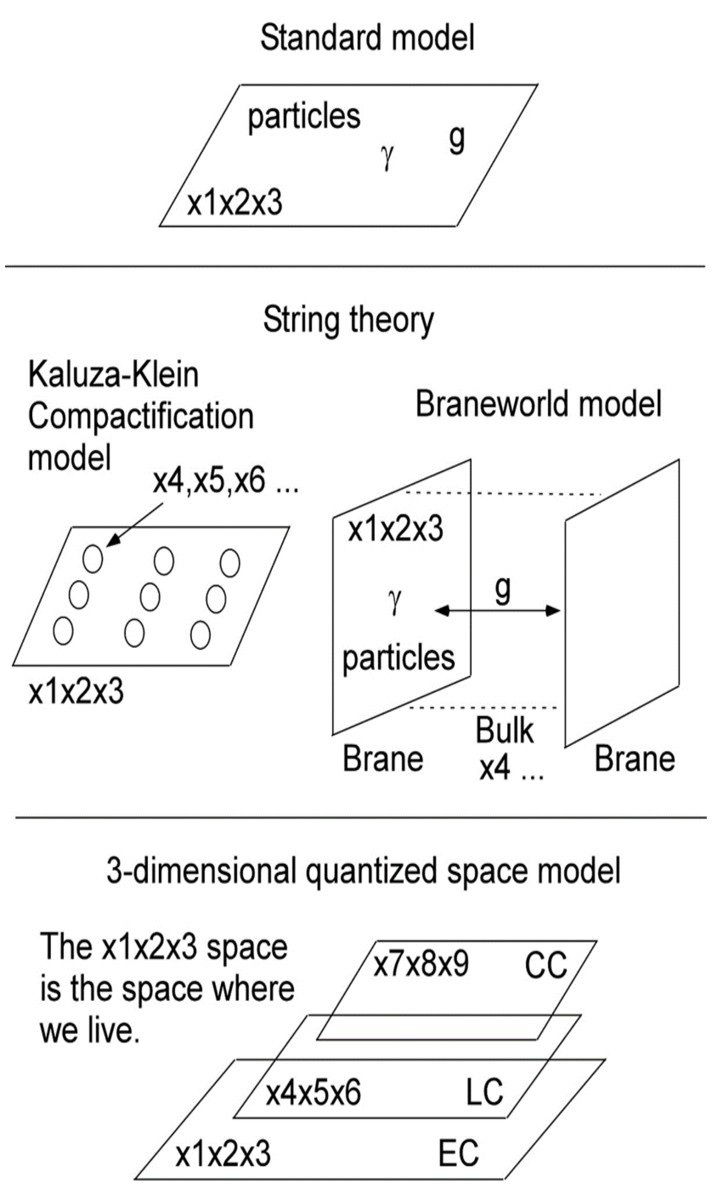
Dark matters

-1 = 2/3 -1/3 -4/3
-3 = 0 -1 -2
-5 = -2/3 -5/3 -8/3

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.

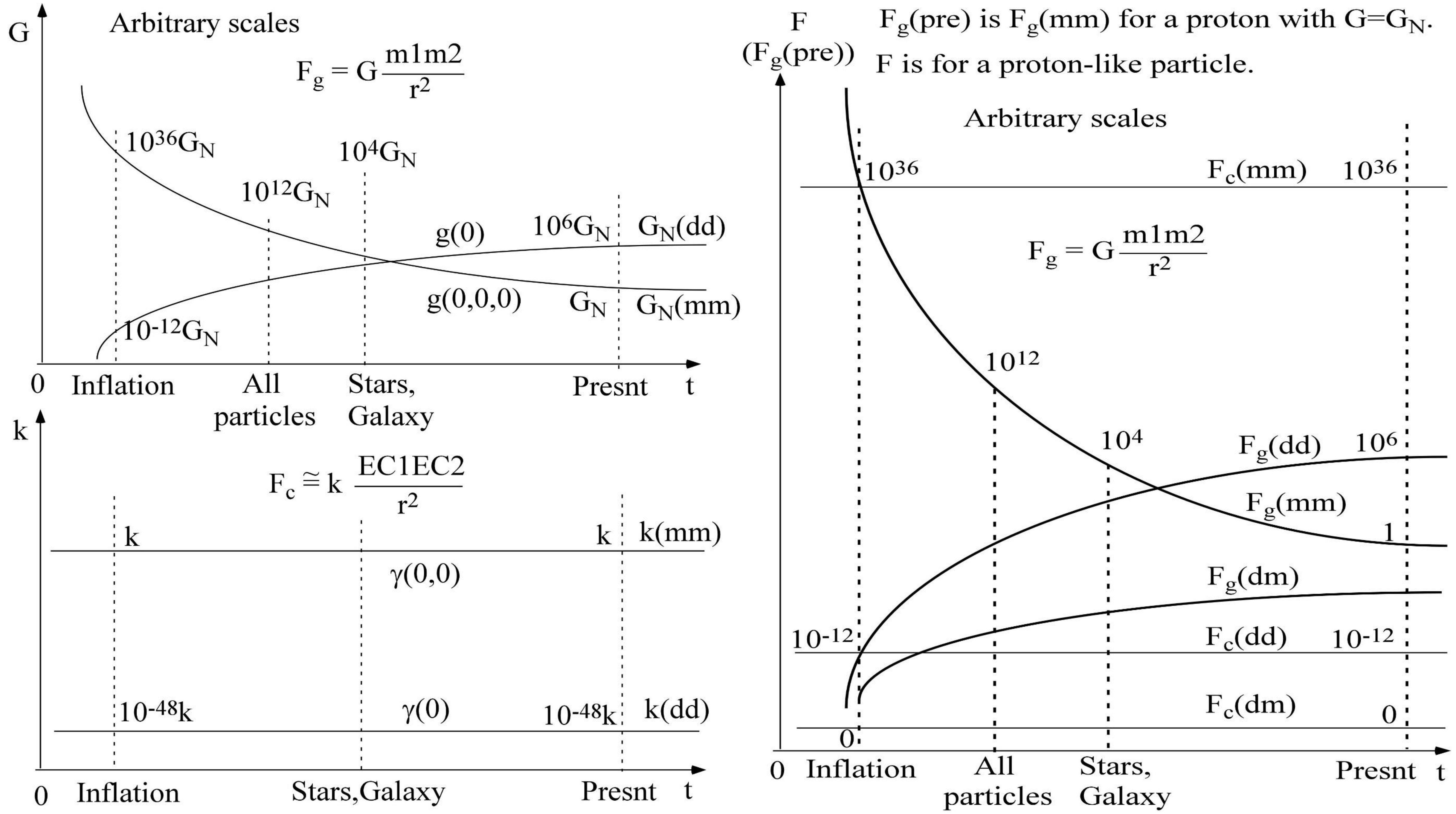

G
Arbitrary scales
$F_g = G\frac{m1m2}{r^2}$
$10^{36}G_N$
$10^{4}G_N$
$10^{12}G_N$
g(0)
$10^{6}G_N$
$G_N(dd)$
g(0,0,0)
G_N
$G_N(mm)$
$10^{-12}G_N$
0
Inflation
All particles
Stars, Galaxy
Presnt
t
k
$F_c \cong k\,\frac{EC1EC2}{r^2}$
k
k
k(mm)
$\gamma(0,0)$
$10^{-48}k$
$\gamma(0)$
$10^{-48}k$
k(dd)
0
Inflation
Stars,Galaxy
Presnt
t
F
(F_g(pre))
F_g(pre) is F_g(mm) for a proton with $G=G_N$.
F is for a proton-like particle.
Arbitrary scales
10^{36}
F_c(mm)
10^{36}
$F_g = G\frac{m1m2}{r^2}$
10^{12}
10^{4}
F_g(dd)
10^{6}
F_g(mm)
1
F_g(dm)
10^{-12}
F_c(dd)
10^{-12}
F_c(dm)
0
0
0
Inflation
All particles
Stars, Galaxy
Presnt
t

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

Particles [1]	E_p(mm), (eV)	$G = G_N(\text{mm}) = 10^x G_N$
γ	≈ 0	$\approx \infty$, Big bang
Graviton	10^{-30}	$10^{116} G_N$
ν_e	10^{-2}	$10^{60} G_N$
B1	10^{2}	$10^{52} G_N$
e, u, d	10^{6}	$10^{44} G_N$
p, n	10^{10}	$10^{36} G_{N,}$ $\approx$ Inflation
W(-1,0), Z(0,0), Baryons, B2	10^{11}	$10^{34} G_N$
Le, Nuclei, Atoms, Gas	10^{13}	$10^{30} G_N$
All elementary particles	10^{22}	$10^{12} G_{N,}$ $\approx 10^5$ years
Stars, Galaxies	10^{26}	$10^{4} G_{N,}$ $\approx 10^8$ years
Present Planck mass	10^{28}	G_N, $\approx 10^9$ years

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)

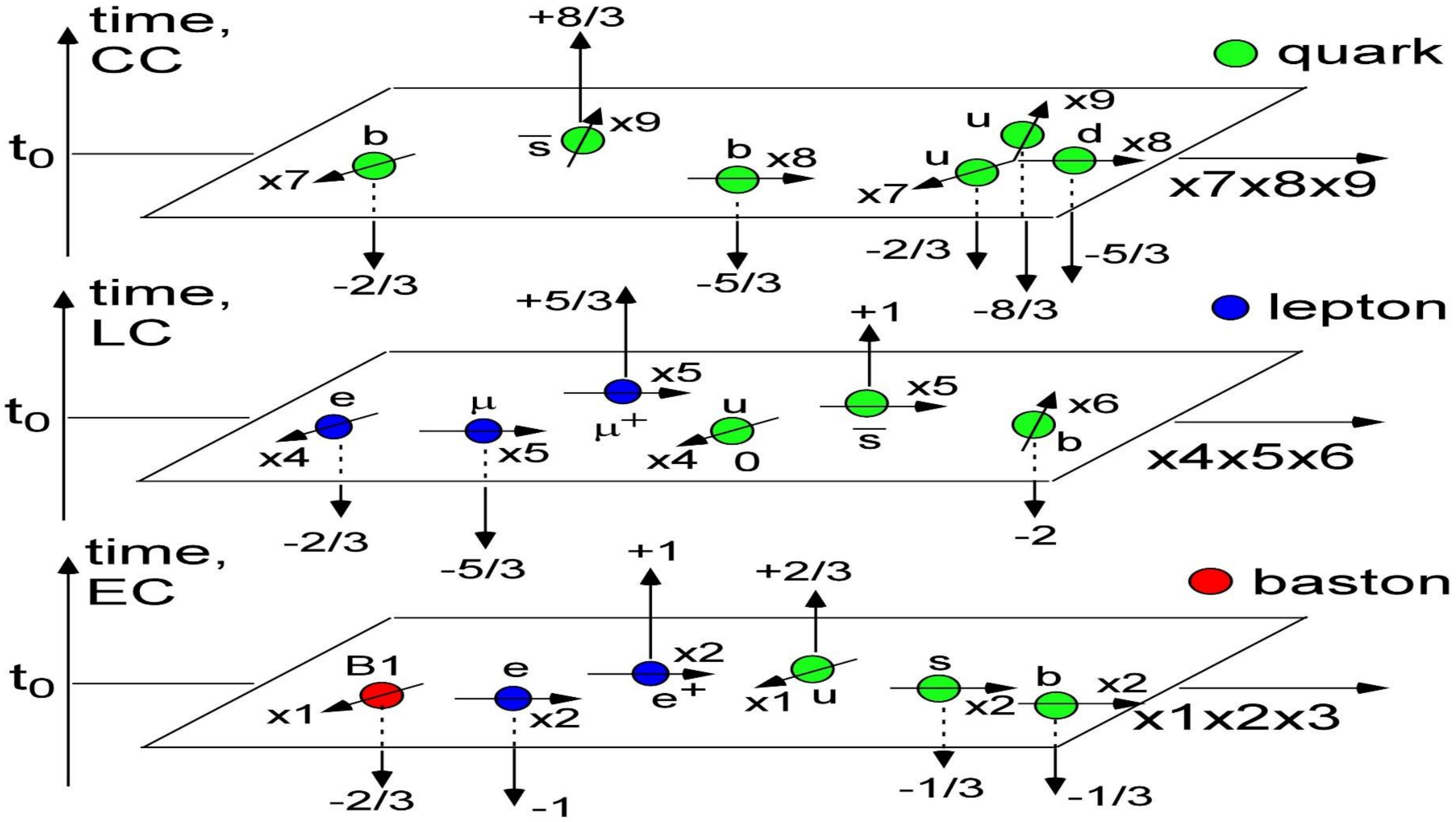
Three-dimensional quantized space model

Electric charge (EC); Lepton charge (LC); Color charge (CC)

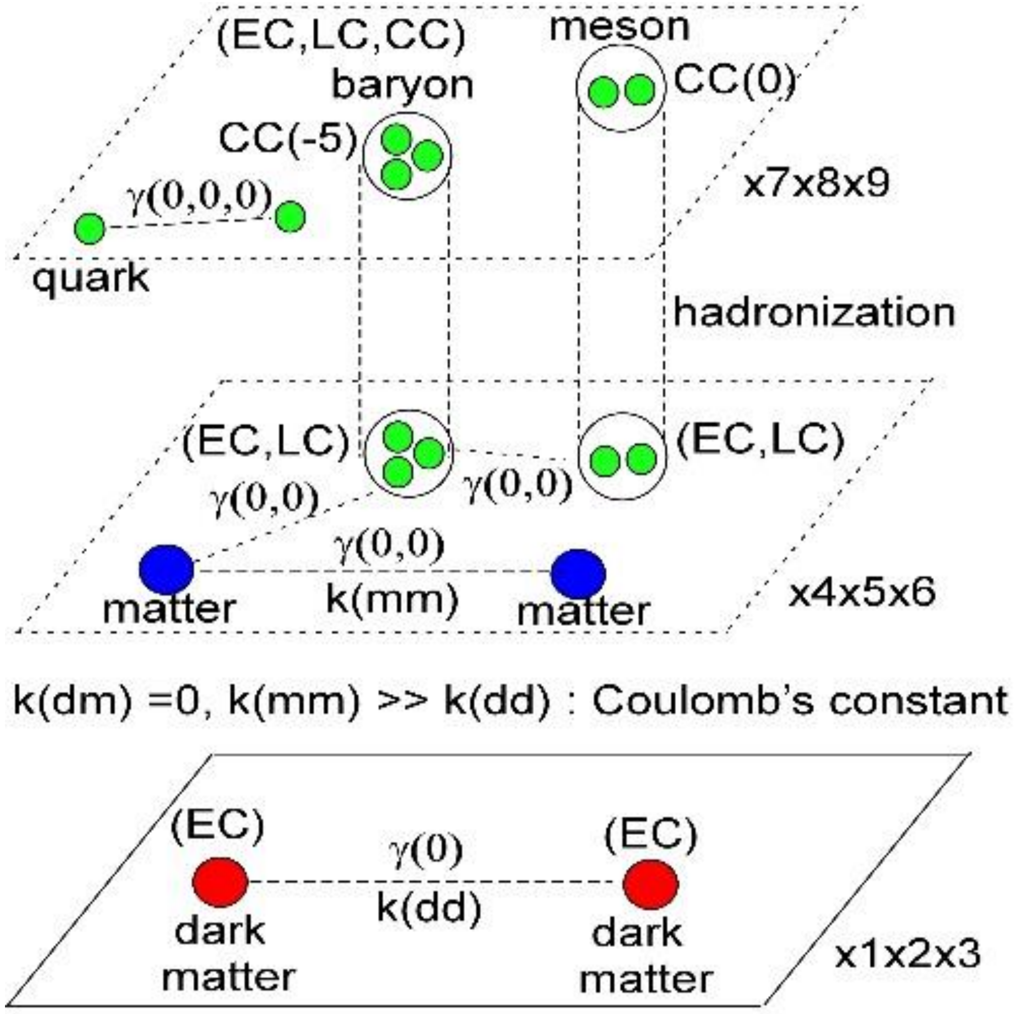
Bastons(Dark matters) (EC); Leptons (EC,LC); Quarks (EC,LC,CC)

Baryons (EC,LC,-5); Mesons (EC,LC,0)

Charge conservations of EC, LC and CC

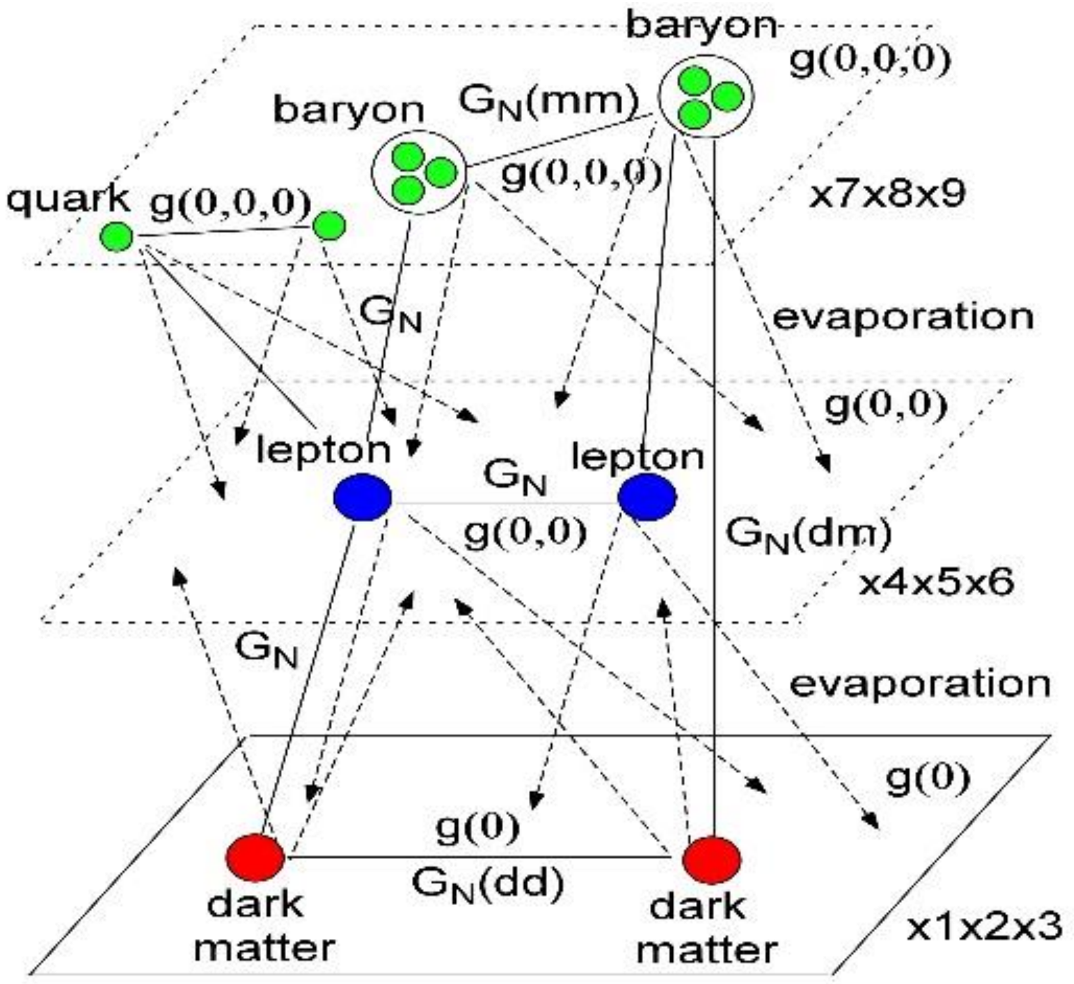


Negative and positive charges along the negative time axis and positive time axis, respectively, can be added and subtracted like the scalars on the three-dimensional quantized spaces.The EC, LC and CC charges are different from the vectors like the angular momenta on the three-dimensional quantized spaces.



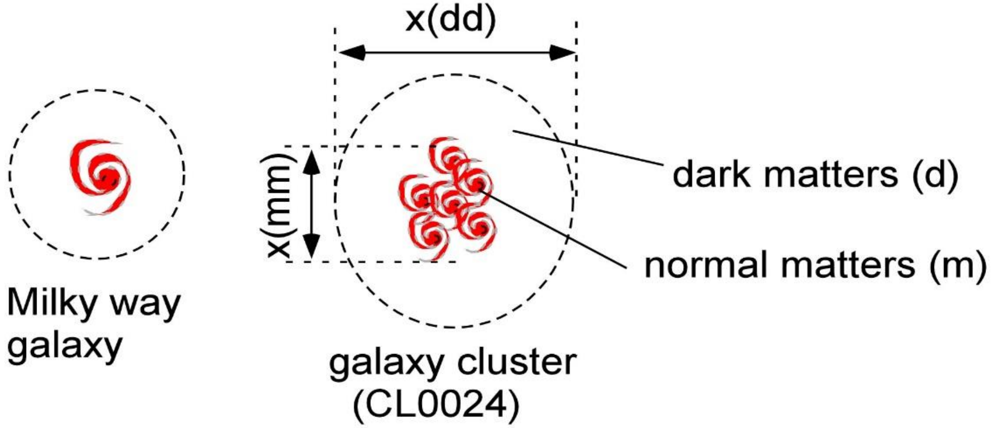
$\gamma(0) \underset{\leftarrow}{\overset{X}{\rightleftharpoons}} \gamma(0,0) \underset{\leftarrow}{\overset{X}{\rightleftharpoons}} \gamma(0,0,0)$: confinement

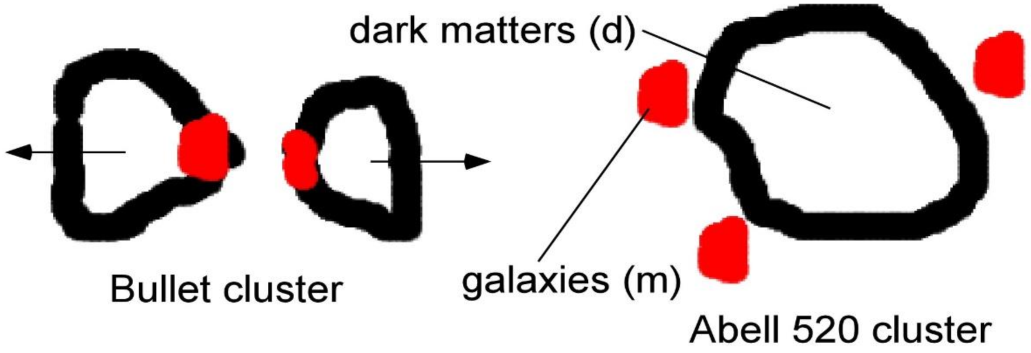
No evaporation of the photons (electromagnetic fields) causes the strong electromagnetic force compared with the weak gravitational force.



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

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

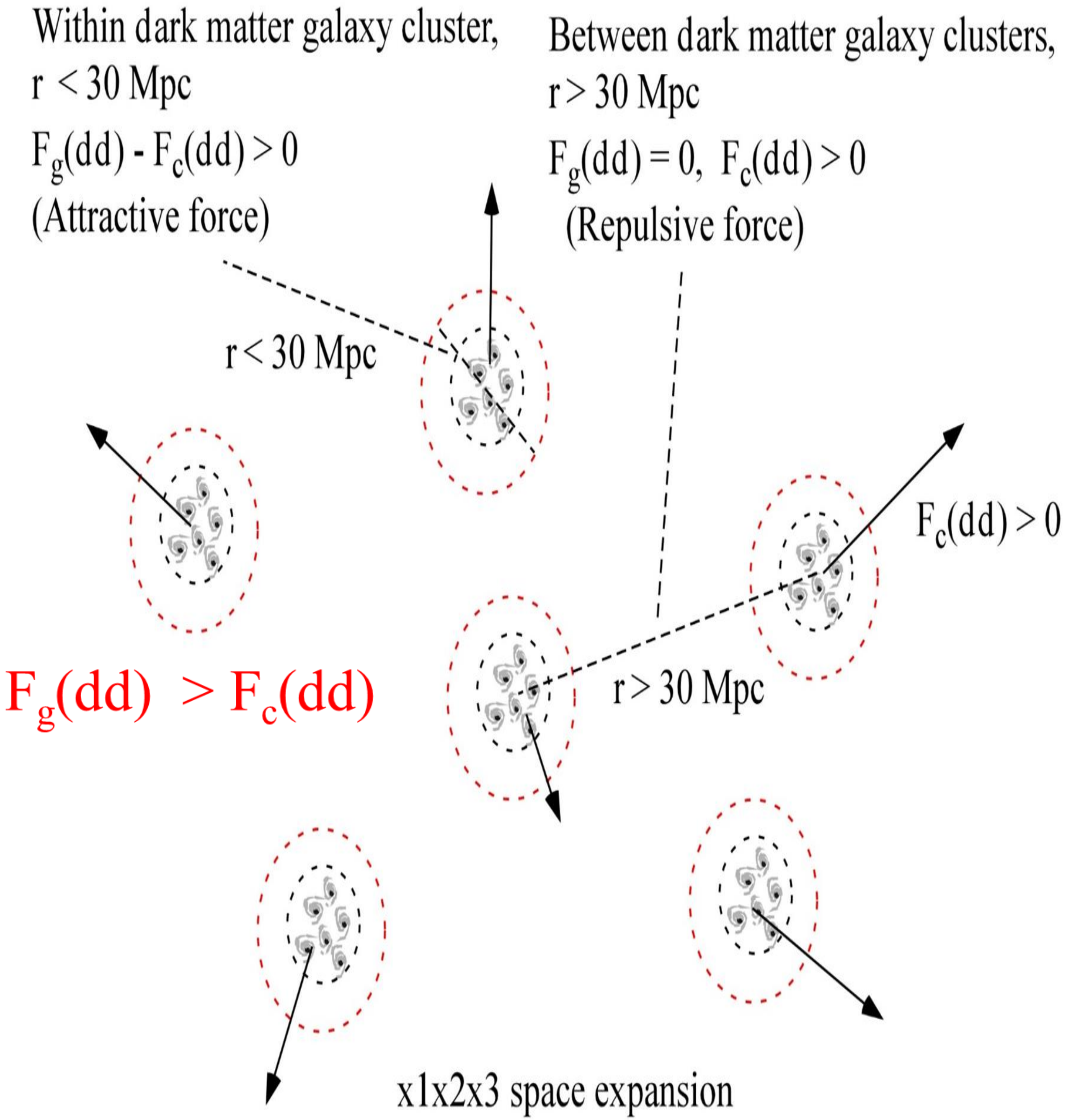


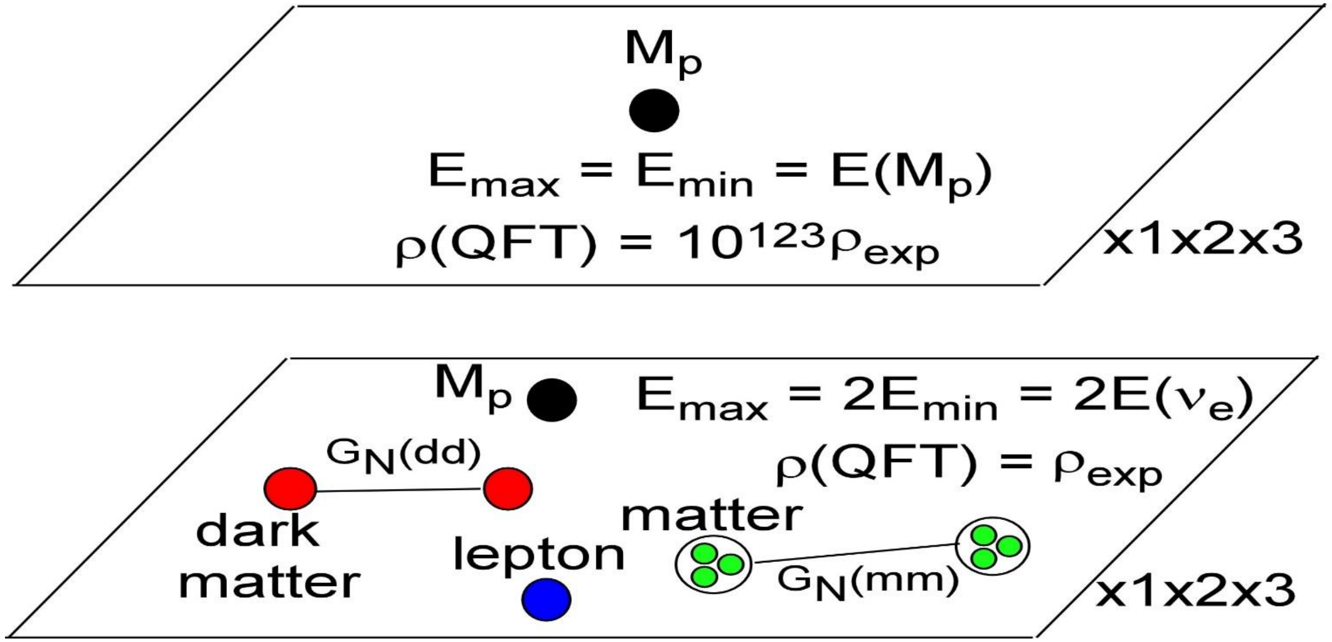


For the proton-like particle;
F_g : gravitational force strength
F_c : electromagnetic force strength
$F_c(mm) > F_g(dd) > F_g(mm) > F_g(dm) > F_c(dd) > F_c(dm) = 0$

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

ρ_{exp}: vacuum energy density

$\rho(QFT) = 2.64\ (E_{max})^4\ \mathrm{erg/cm^3}$

$\rho_{exp} = 6.29\ 10^{-9}\ \mathrm{erg/cm^3}$

E_{max}: maximum vacuum oscillation energy

E_{min}: minimum rest mass energy of a particle

$E(\nu_e)$: rest mass energy of an electron neutrino

$E_{max} = 2E_{min} = 2E(\nu_e)$, energy unit: eV

From $\rho(QFT) = \rho_{exp}$,

$E(\nu_e) = 3.494\ 10^{-3}$ 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 (ν_e, ν_μ, ν_τ, e, μ, τ)

$E = 0.4498\ 10^{38+2F}$ for leptons ($Le, L\mu, L\tau$)

based on $m(Le) = 1.4\ TeV/c^2$.

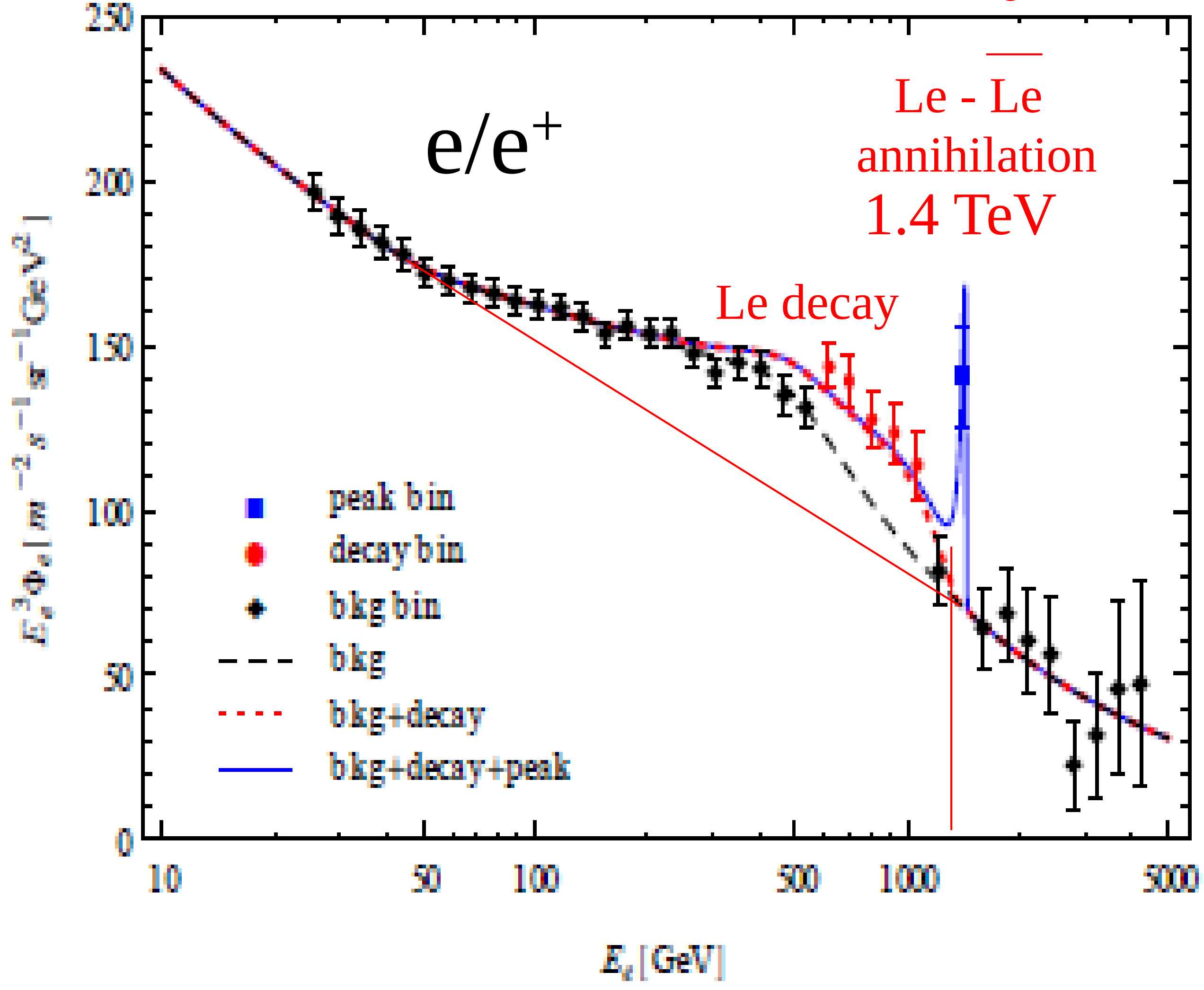
$E = mc^2$; energy unit: eV

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.

(EC,LC)	E_{exp} (eV)	E_{calc} (eV)	(EC,LC)	E_{exp} (eV)	E_{calc} (eV)
$\nu_e(0,-2/3)$	?	$2.876\ 10^{-7}$	e(-1,-2/3)	$5.11\ 10^{5}$	$5.11\ 10^{5}$
$\nu_\mu(0,-5/3)$	?	$5.947\ 10^{-5}$	μ(-1,-5/3)	$1.057\ 10^{8}$	$1.057\ 10^{8}$
$\nu_\tau(0,-8/3)$	?	$1.000\ 10^{-1}$	τ(-1,-8/3)	$1.777\ 10^{9}$	$1.777\ 10^{9}$
$L_e(-2,-2/3)$	$1.4\ 10^{12}$	$1.4\ 10^{12}$	B1(-2/3)	26.121	26.121
$L_\mu(-2,-5/3)$	?	$2.896\ 10^{14}$	B2(-5/3)	$4.27\ 10^{10}$	$4.27\ 10^{10}$
$L_\tau(-2,-8/3)$	?	$4.871\ 10^{17}$	B3(-8/3)	?	$1.948\ 10^{15}$

The rest mass energies of the leptons and bastons (dark matters) are calculated and compared with the experimental values.

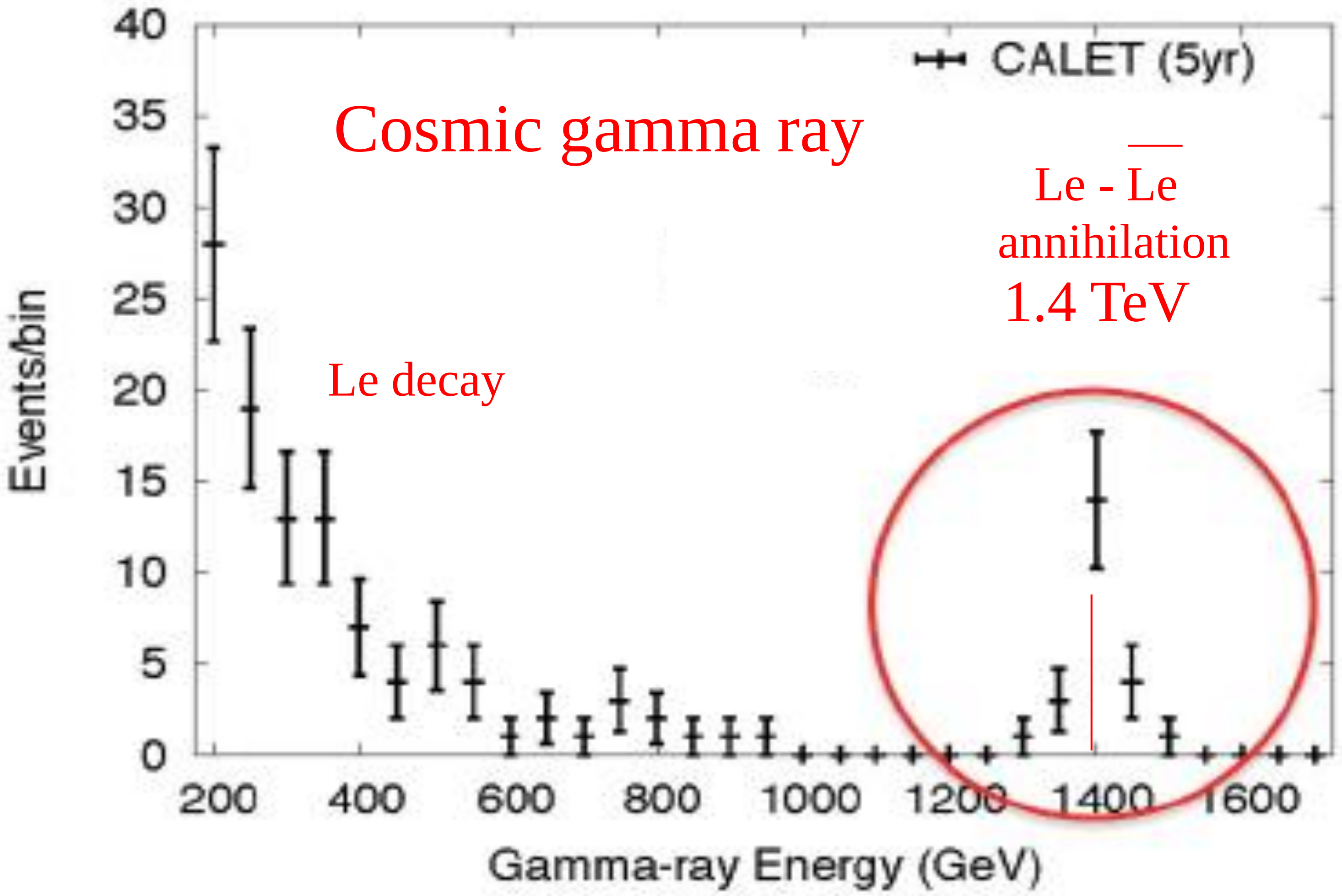
$$Le \longrightarrow e + e + \overline{\nu}_e$$



A rest mass of Le could be 1.4 TeV/c^2.

Cosmic-ray electron/positron excess at DAMP (Dark Matter Particle Explorer) S.F. Ge and H.J. He, arXiv: 1712.02744 (2017).

These data support the existence of heavy leptons like Le, Lμ and Lτ.



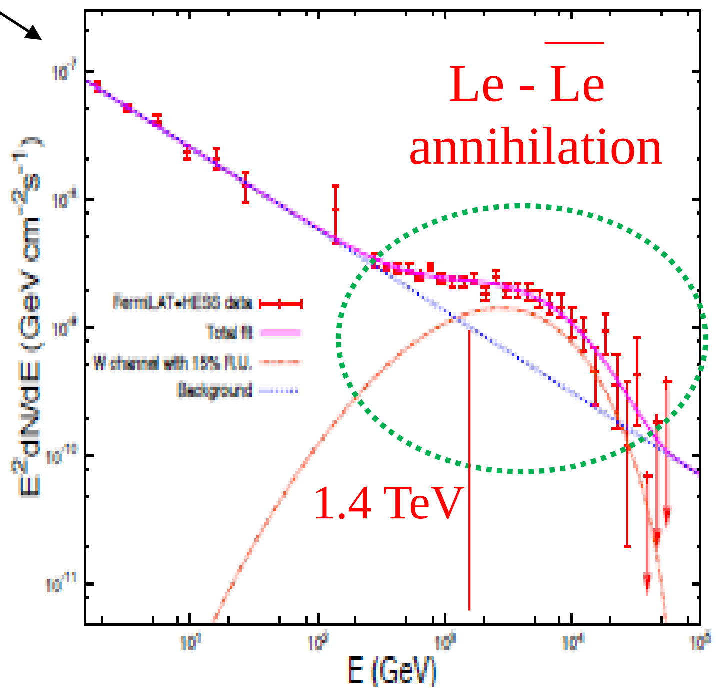
Cosmic gamma ray spectrum by CALET 5 year measurements from the Galactic center including galactic diffusing background

O. Adriani et al., EPJ Web of Conf. 95, 04056 (2015).

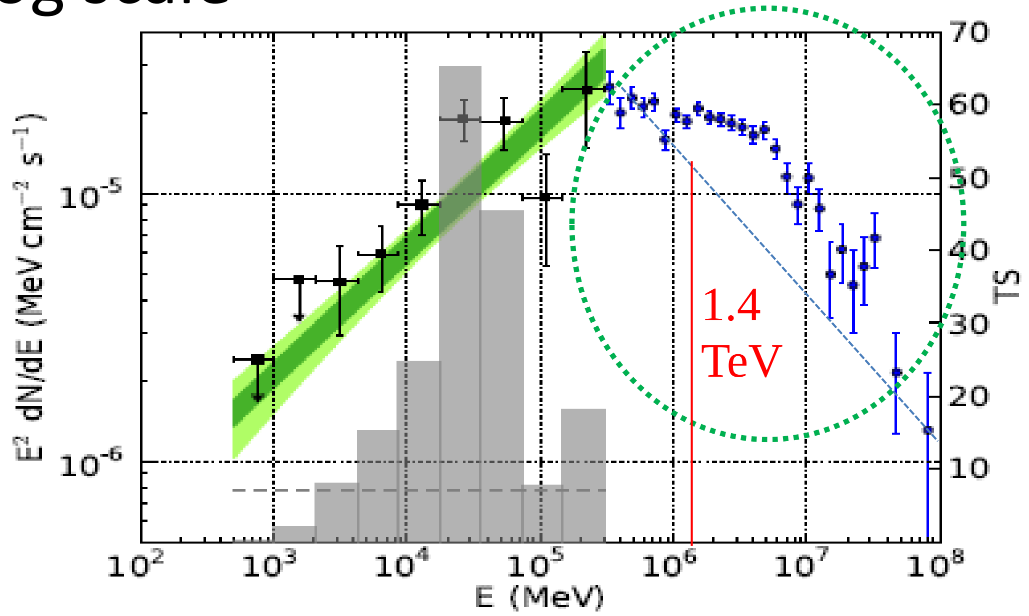
These data support the existence of heavy leptons like Le, Lμ and Lτ.

Le – anti Le annihilation peak.

log scale



log scale



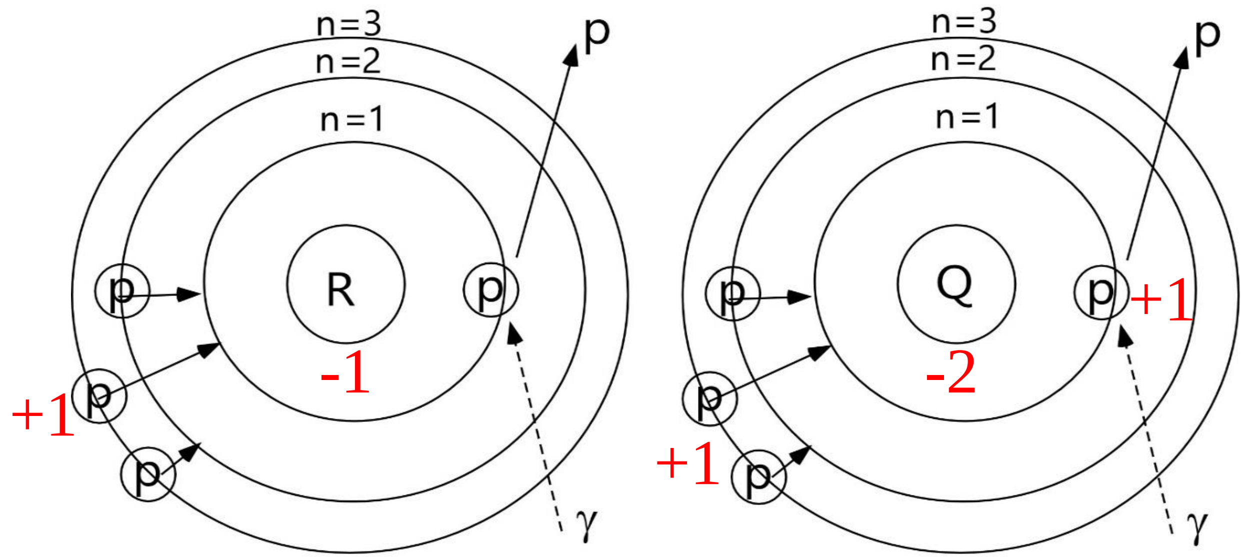
V. Gammaldi, arXiv: 1412.7639 (2014).
TeV gamma ray spectrum from RX J1713.7-3946 with HESS and Fermi-LAT data.

S. Federicici et al., arXiv: 1502.06355v1 (2015).
Analysis of GeV-band gamma-ray emission from SNR RX J1713.7-3946 with HESS and Fermi-LAT data.

A rest mass of Le could be 1.4 TeV/c^2 .

These data support the existence of heavy leptons like Le, Lμ and Lτ.

Heavy Q1 baryon atoms



N(Q1,u,u)(0,0)
Heavy neutral
Q1 baryon

R(Q1,d,u) (-1,0)
p(1,0)

$E_1(x) = E_2 - E_1$
$= 18.7$ keV
$E_2(x) = E_3 - E_2$
$= 3.5$ keV
$E_3(x) = E_3 - E_1$
$= 22.2$ keV

Q(Q1,d,d) (-2,0)
p(1,0)

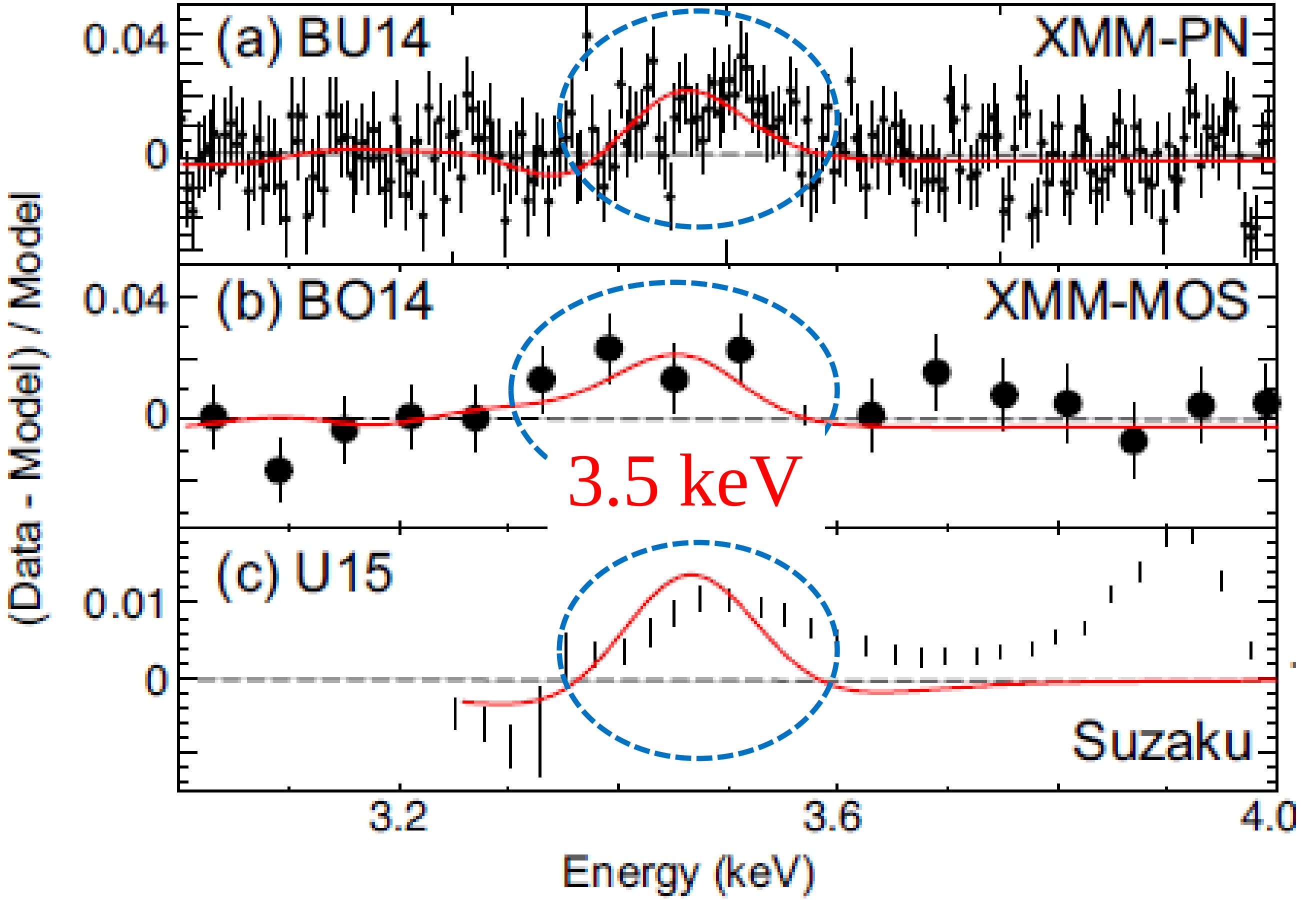
$E_1(x) = E_2 - E_1$
$= 74.9$ keV
$E_2(x) = E_3 - E_2$
$= 13.9$ keV
$E_3(x) = E_3 - E_1$
$= 88.8$ keV

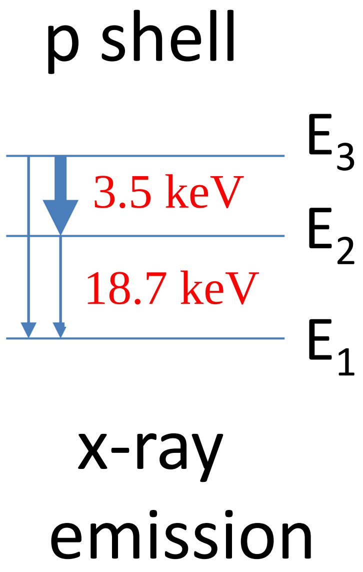
p(u,u,d)(1,0)
Proton

n(u,d,d)(0,0)
Neutron

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 EC = -4/3. This can justify the Q1, Q2 and Q3 quarks.

diffuse cluster x-ray emission

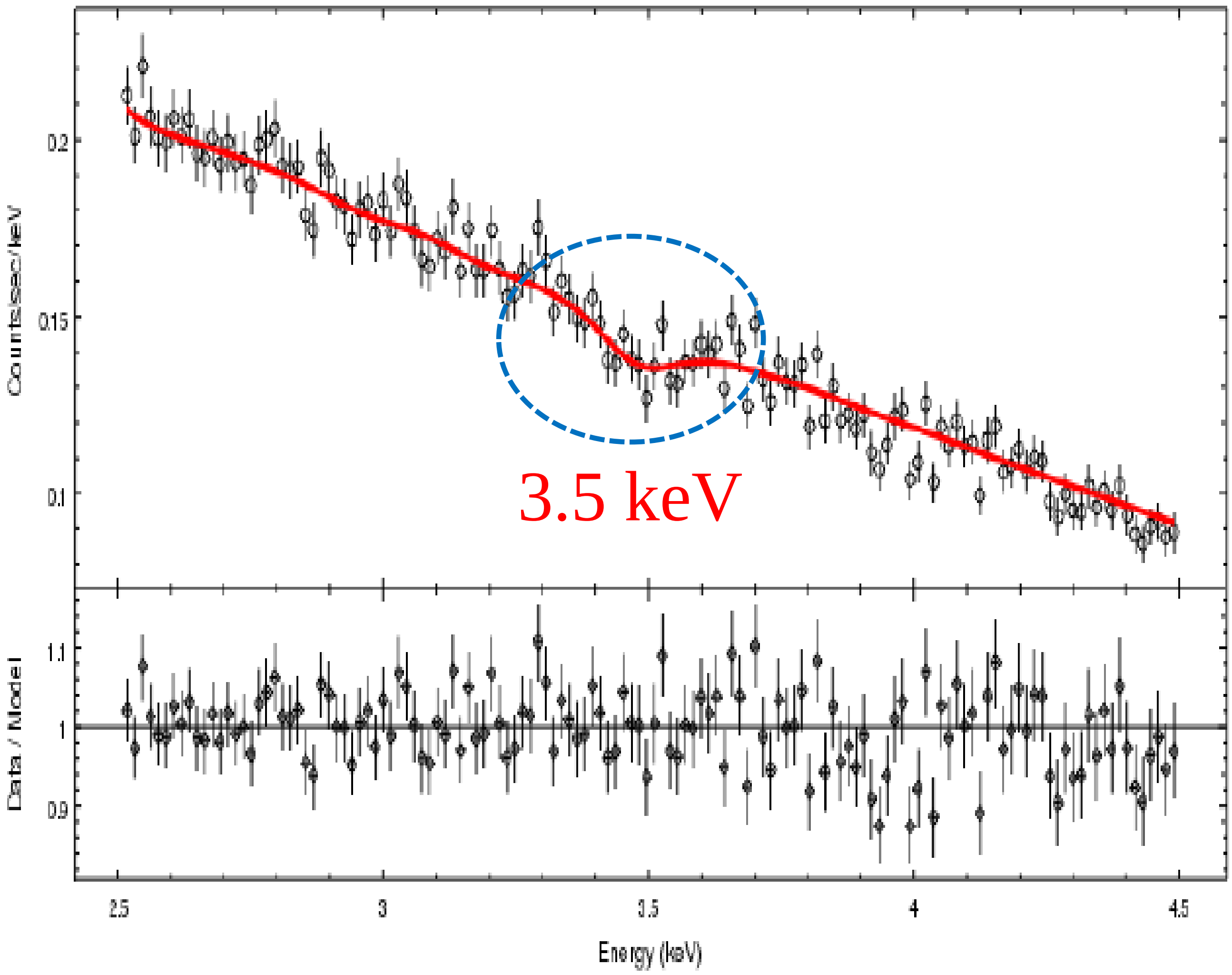


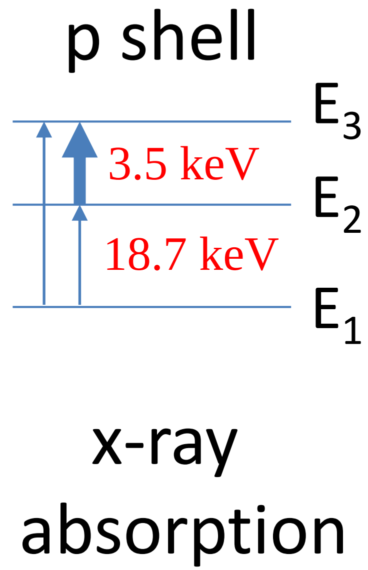


E. Bulbul et al. 2014, ApJ, 789, 13 (BU14). A. Boyarsky et al., 2014, Phys. Rev. Lett., 113, 251301 (BO14).

L. Gu et al., Astronomy & Astrophysics 584, L11 (2015). O. Urban et al. 2015, MNRAS, 451, 2447 (U15).

3.5 keV diffuse x-ray emission line from nearby galaxies and galaxy clusters

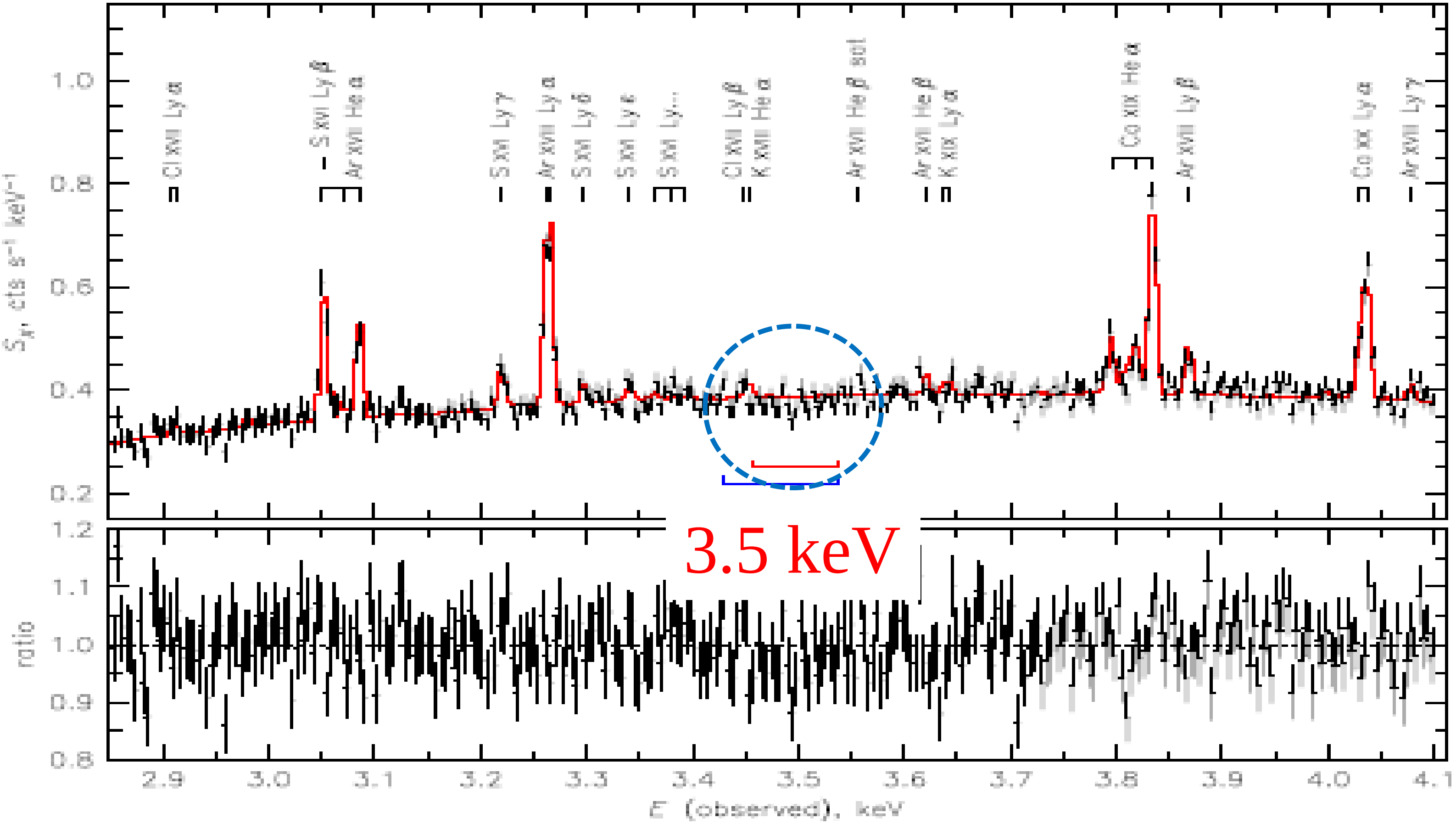




3.5 keV AGN x-ray absorption line from 2009 Chandra data for Perseus cluster

J.P. Conlon et al. arXiv: 1608.01684v3 (2017).

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

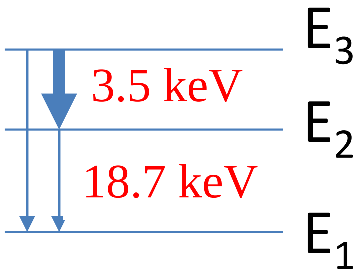


3.5 keV AGN x-ray spectrum with Hitomi for Perseus cluster

F.A. Aharonianet al. arXiv: 1607.007420v2 (2017).

Line energy, keV	Significance σ	Width, keV	F, 10^{-6} cts/cm^2/s	F_{noSun}, 10^{-6} cts/cm^2/s	Sun?	Ghost?
3.51 (2)	11.1	0.08 ± 0.05	7.7 ± 1.3	10 ± 2.5		
$4.46^* \pm 0.05$	15.7	0.12 ± 0.03	5.9 ± 0.5	3.7 ± 0.5	Y	
$4.7^* \pm 0.1$	9.8	0.6 ± 0.1	8.9 ± 1.8	8.2 ± 1.9		
6.32 ± 0.08	6.7	0.	1.2 ± 0.2	0.66 ± 0.23	Y	
7.96 ± 0.06	4.0	0.	0.5 ± 0.1	0.23 ± 0.18	Y	
$10.44^* \pm 0.05$	8.9	0.2 ± 0.05	1.4 ± 0.2	1.7 ± 0.3		
14.2 ± 0.1	3.3	0.	0.51 ± 0.18	0.6 ± 0.2		
14.75 ± 0.05	5.9	0.	0.9 ± 0.2	1.0 ± 0.2		Y?
15.7 ± 0.1	3.7	0.	0.57 ± 0.16	0.6 ± 0.2		Y?
16.7 ± 0.1	5.5	0.	0.9 ± 0.2	1.2 ± 0.2		Y?
19.66(6)	9.3	0.06 ± 0.14	1.3 ± 0.3	1.3 ± 0.3		Y?

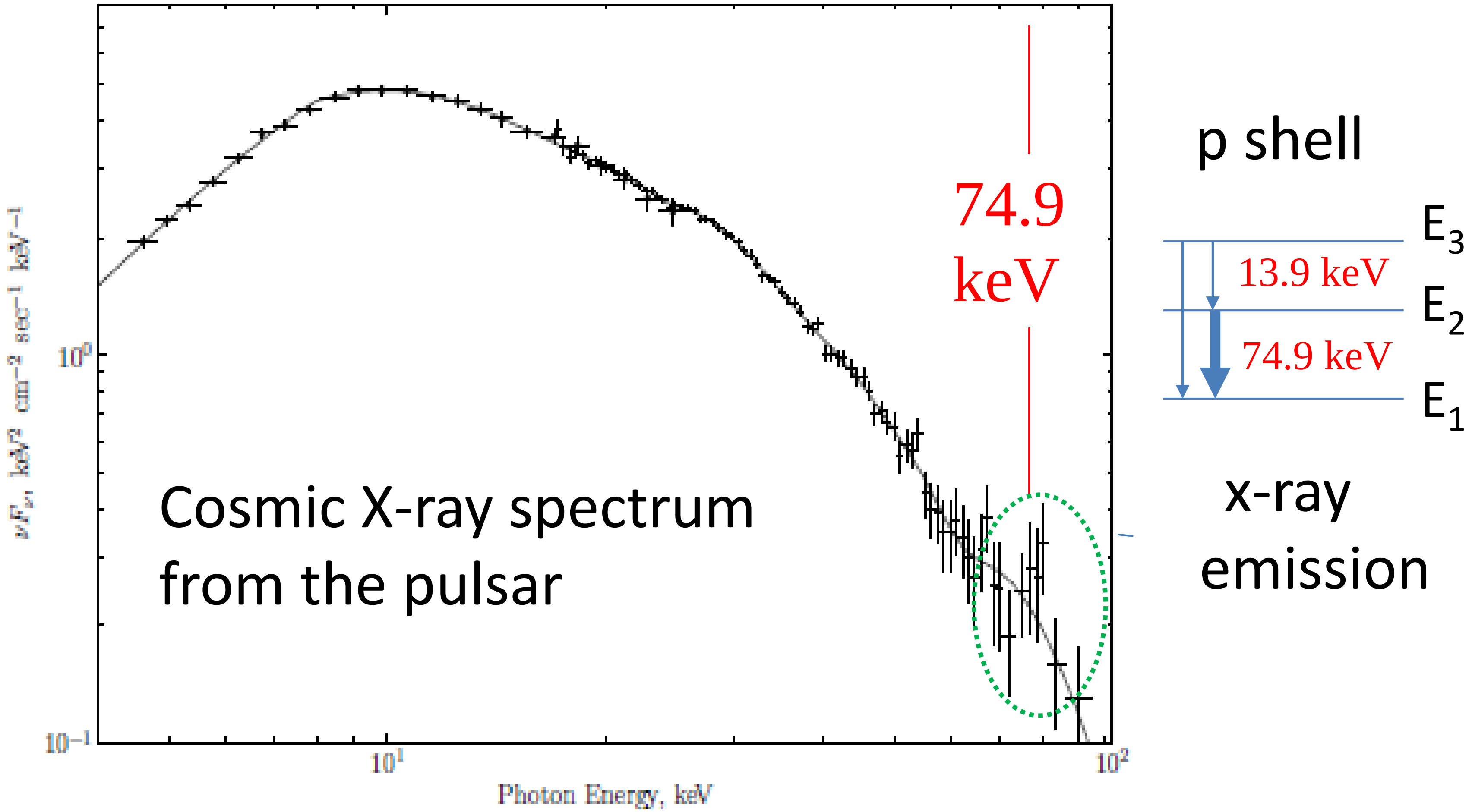
p shell



x-ray emission

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

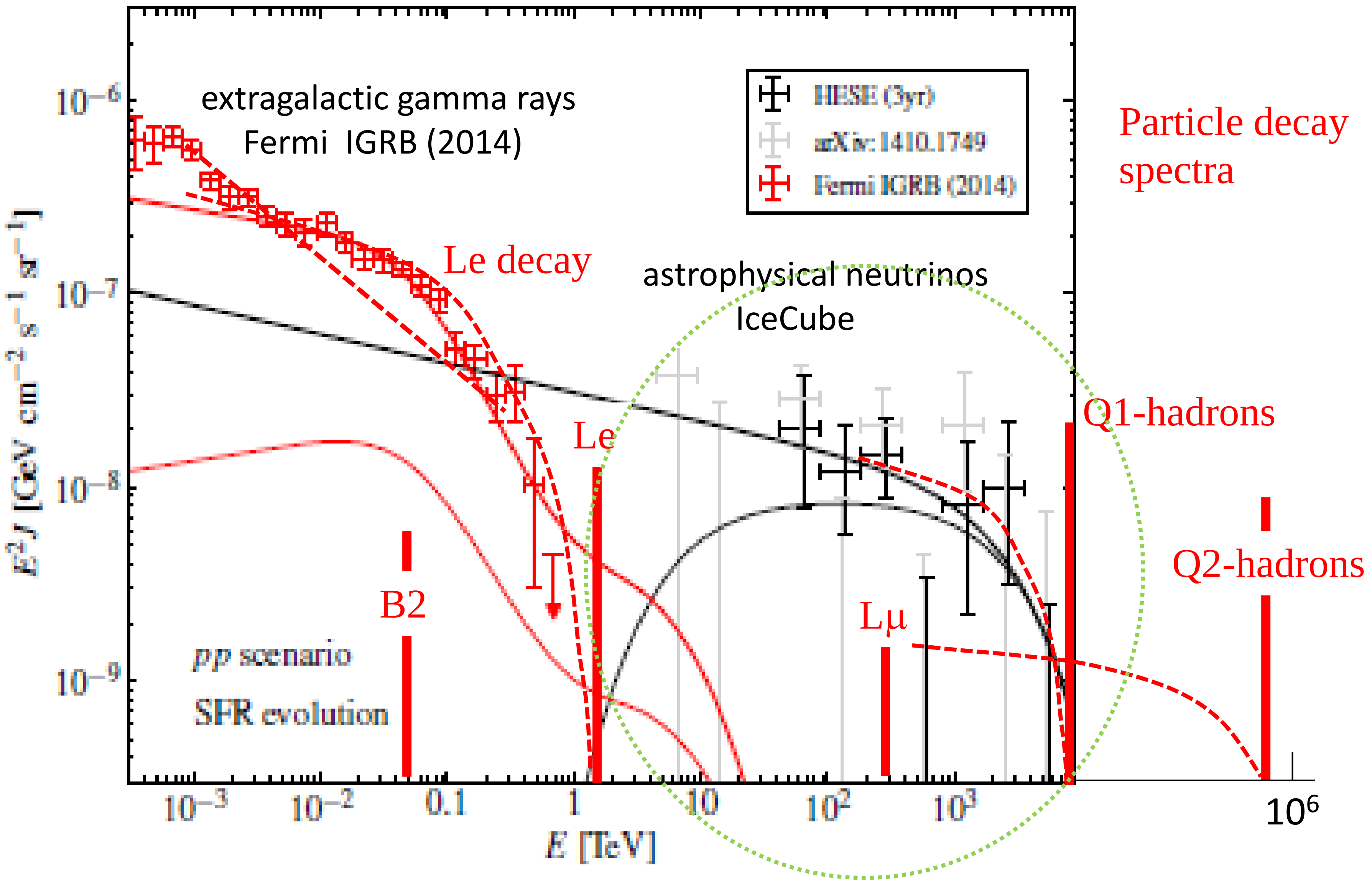
Decaying dark matter search with NuSTAR deep sky observation
A. Neronov et al., arXiv:1607.07328v1 (2016)



Broadband energy spectrum of the X-ray pulsar 4U 0115+63 from IBIS/ISGRI and JEM-X(INTEGRAL) data in its bright state during the out burst in May-June 2011.
P.A. Boldin et al., Astronomy Letters 39, 375 (2013).

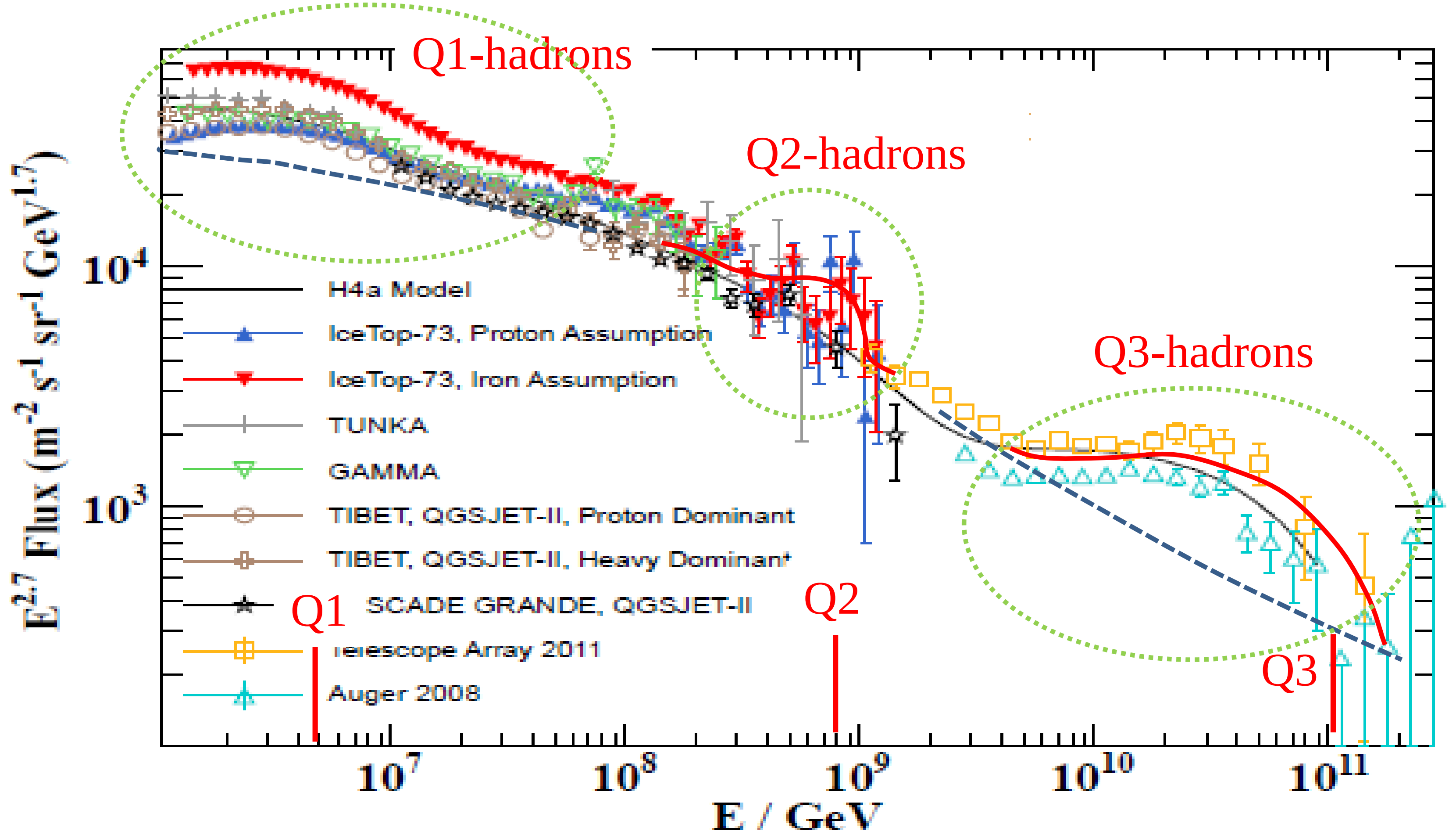
Possible discoveries of 3.5 keV and 74.9 keV x ray peaks support the existence of the new heavy Q1 quark with EC = -4/3. This can justify the Q1, Q2 and Q3 quarks.

Ultra high energy neutrino measurements



M.G. Aartsen et al., arXiv: 1412.5106 (2014)

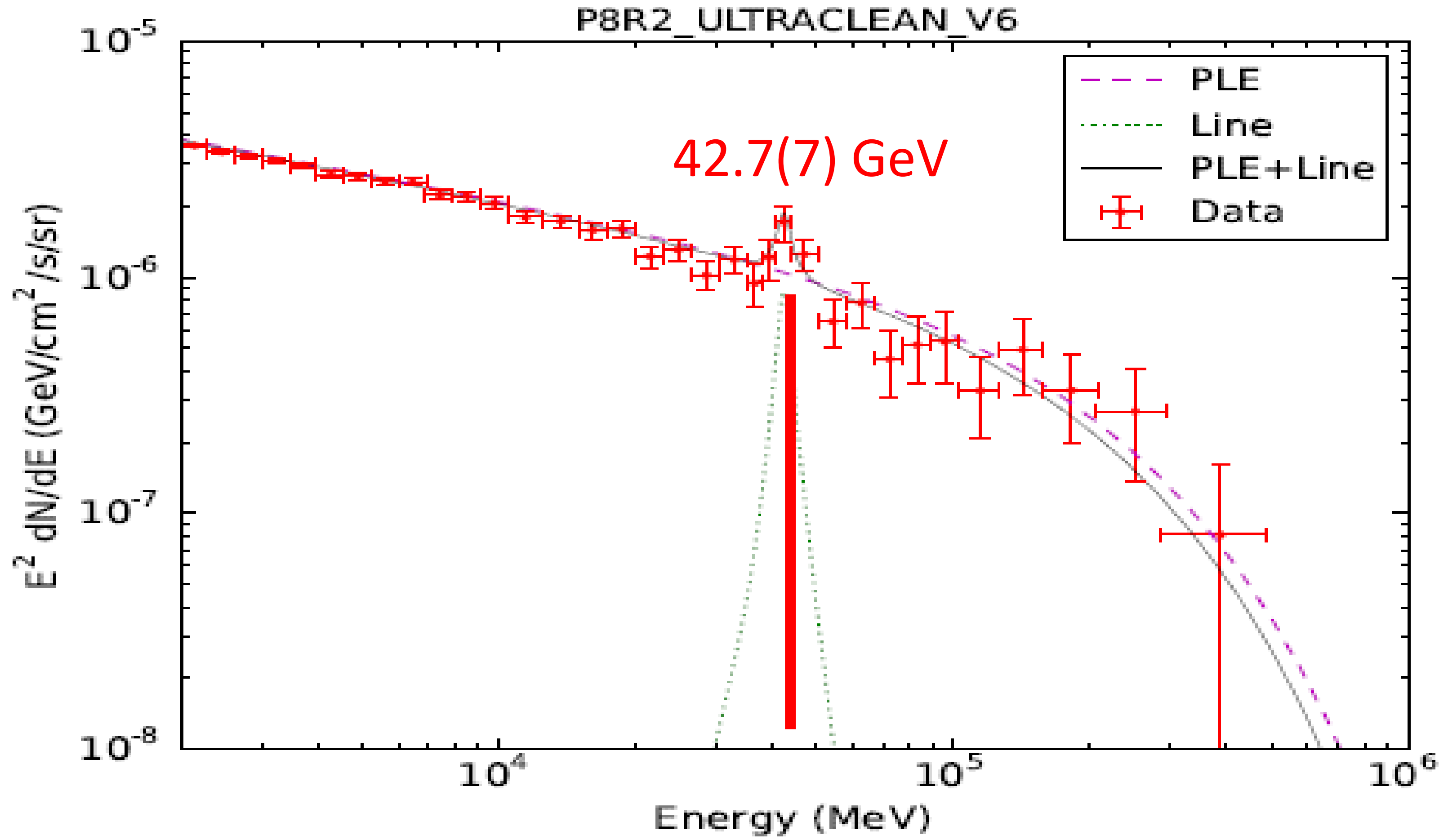
IceCube-Gen2: A Vision for the Future of Neutrino Astronomy in Antarctica



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 $E(Q1) = 5\ 10^{15}$ eV, $E(Q2) = 7\ 10^{17}$ eV and $E(Q3) = 10^{20}$ eV.

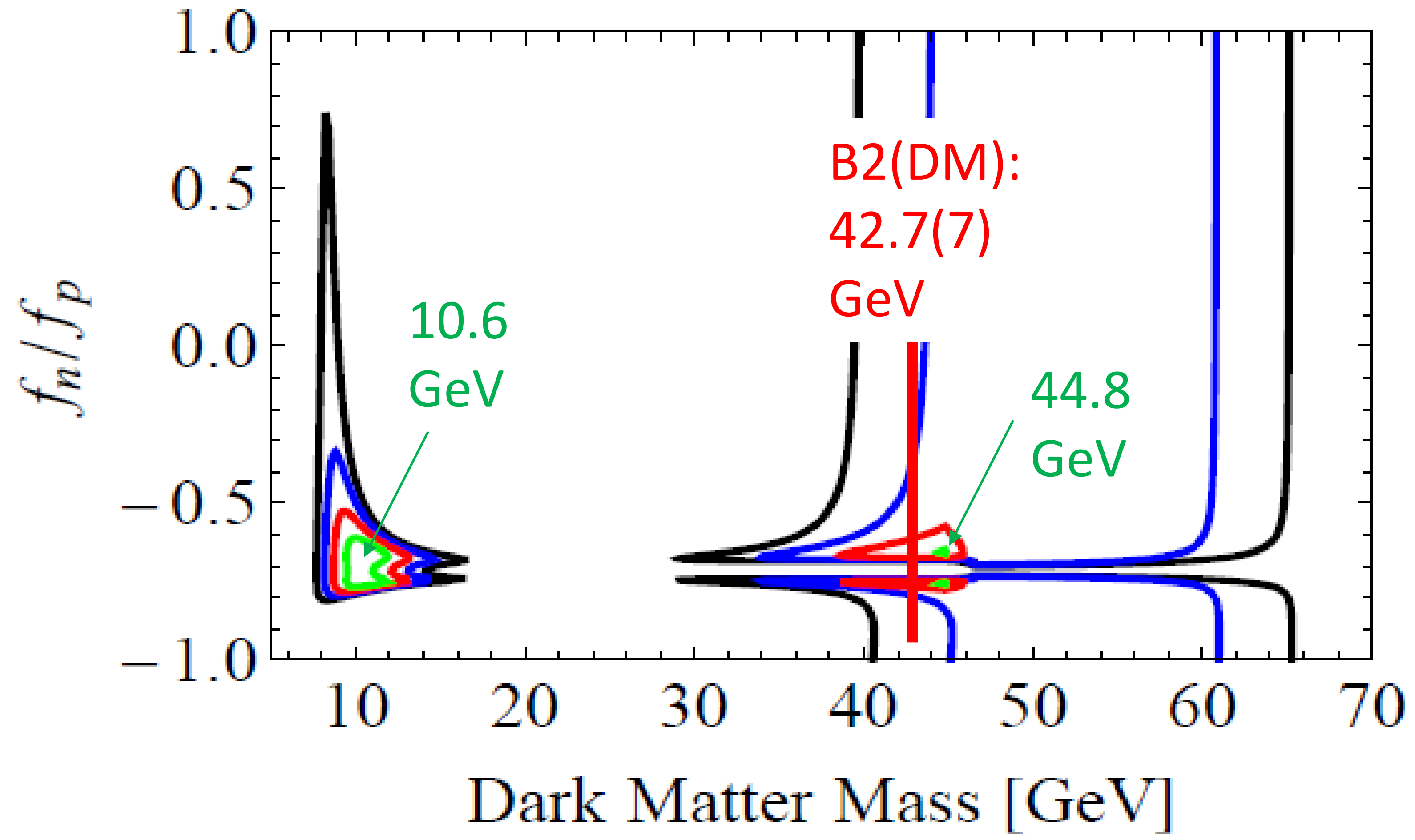
B2 fermionic dark matter measurements



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).

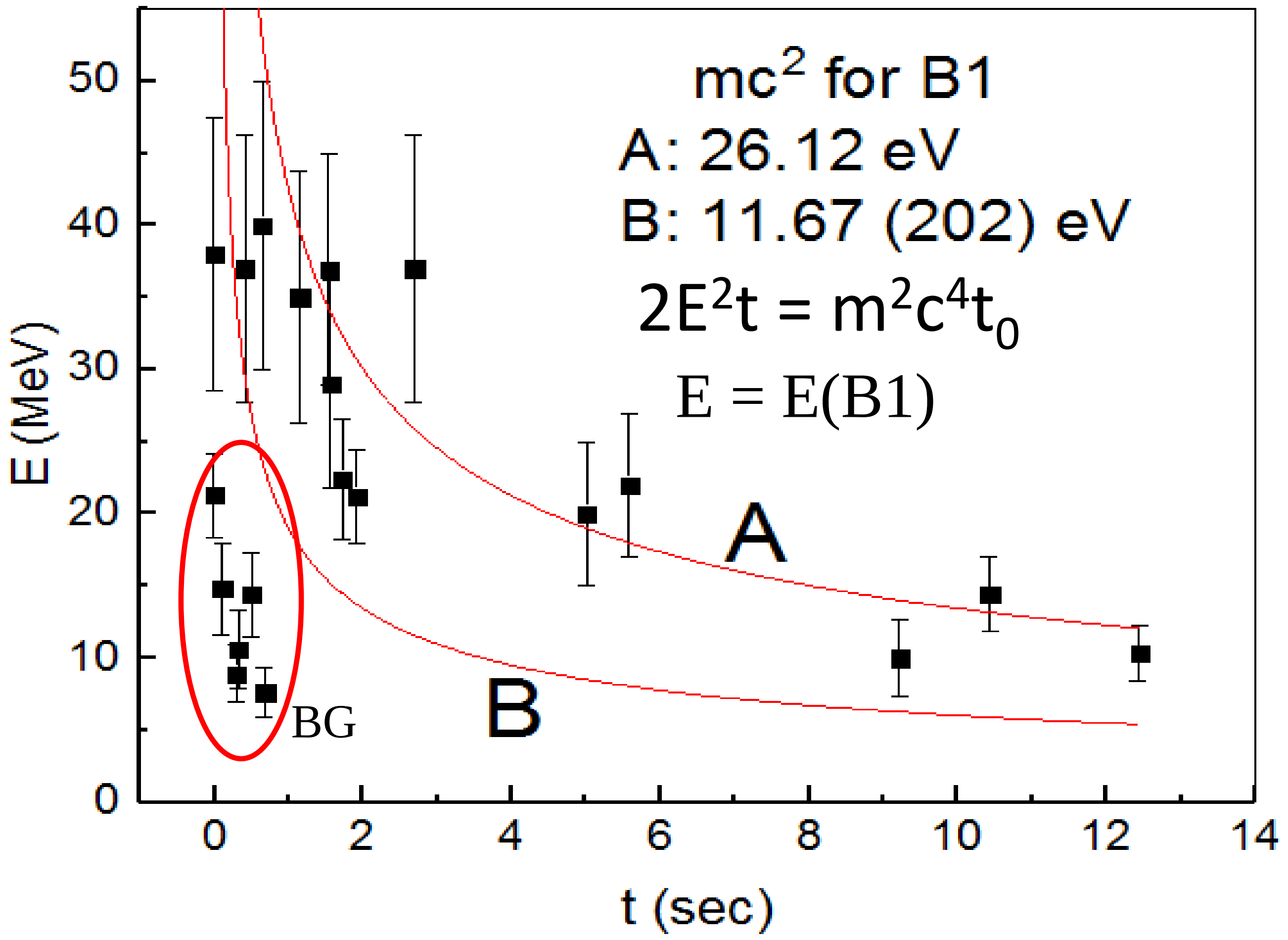
The 42.7 GeV peak is proposed as the B2 annihilation peak.



Dark matter rest mass energy was reported around the energies of 10.6 GeV or 44.8 GeV (~ 42.7 GeV ?).

Dark Matter implications of DAMA/LIBRA-phase2 results

S. Baum etal., ArXiv:1804.01231v1 (2018)



Elastic scattering

$\nu + e^- \rightarrow \nu + e^-$

$B1 + e^- \rightarrow B1 + e^-$

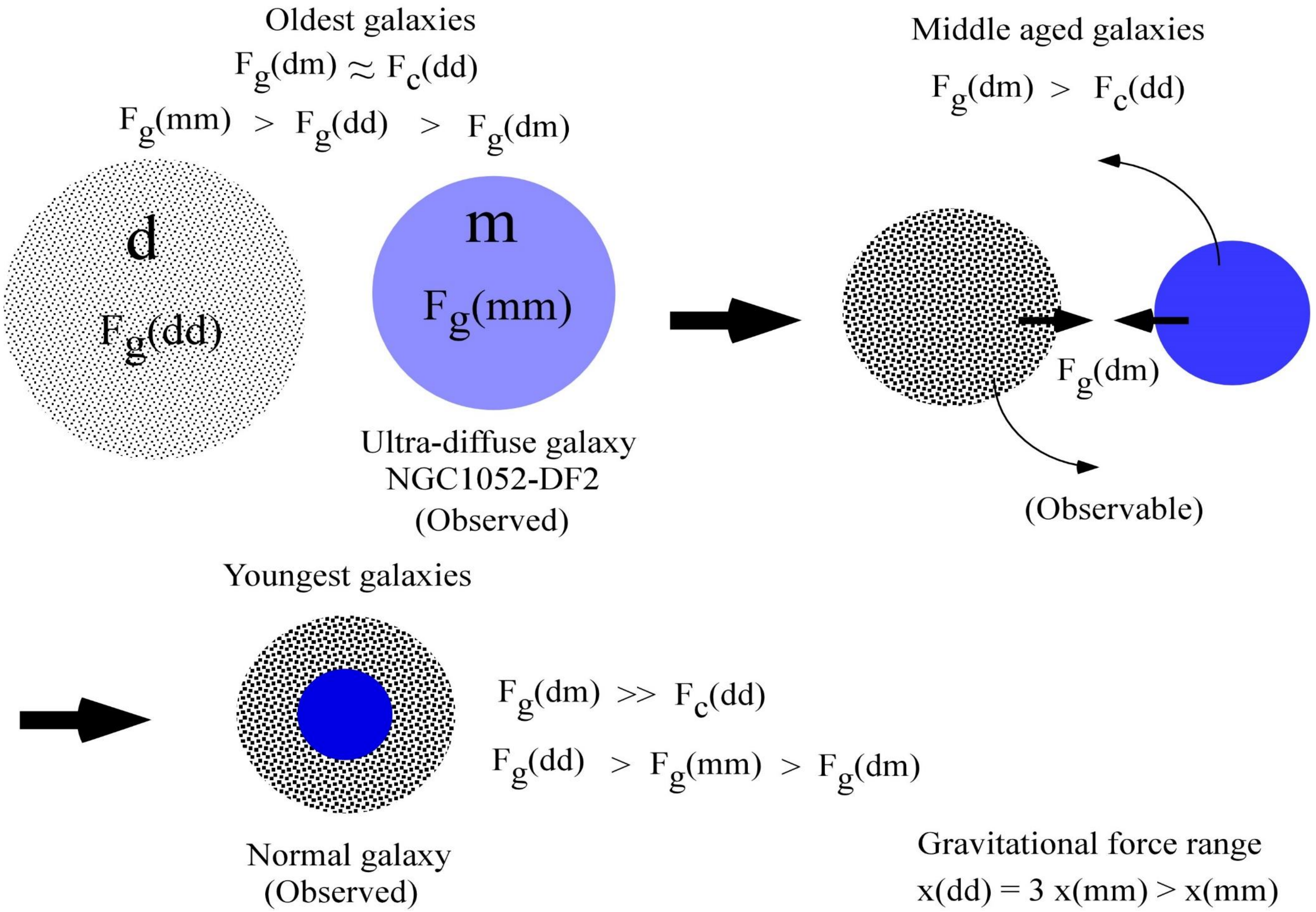
Anti neutrino data → B1 dark matter data
Kamiokande-II + IMB

BG: background counts (6 data)

Baksan data: background counts (5 data) not shown here

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(ν) 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.

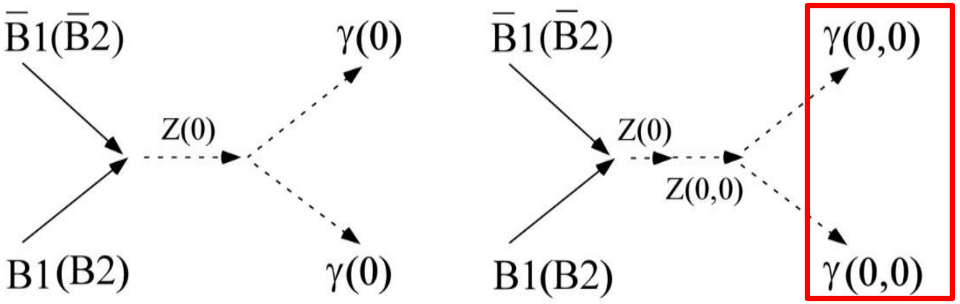
R. Ehrlich, Astropart. Phys. 35, 625 (2012).



NGC1052-DF2 without the dark matters: P. van Dokkum et al., Nature **555**, 629 (2018).

particle - anti particle annihilations

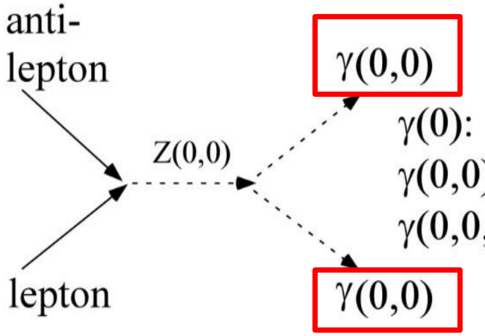
$I(\gamma(0)) >> I(\gamma(0,0))$
(Dark matters)



Observable (weak)

Difficult but possible to be observed at LHC

$I(\gamma(0,0)) >> I(\gamma(0))$
(Leptons,Hadrons)



Based on the x1x2x3 universe

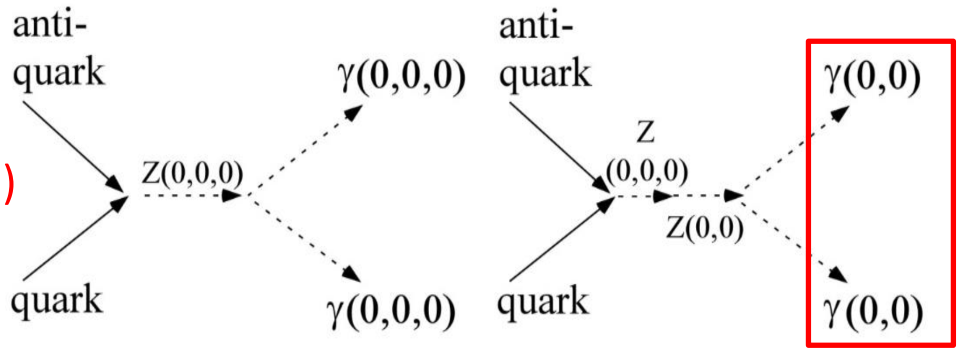
$\gamma(0)$: baston photon (dark photon)

$\gamma(0,0)$: lepton photon (normal photon)

$\gamma(0,0,0)$: quark photon (unobservable photon)

$\gamma(0,0)$: Observable (strong)

$I(\gamma(0,0,0)) >> I(\gamma(0,0))$
(Quarks)

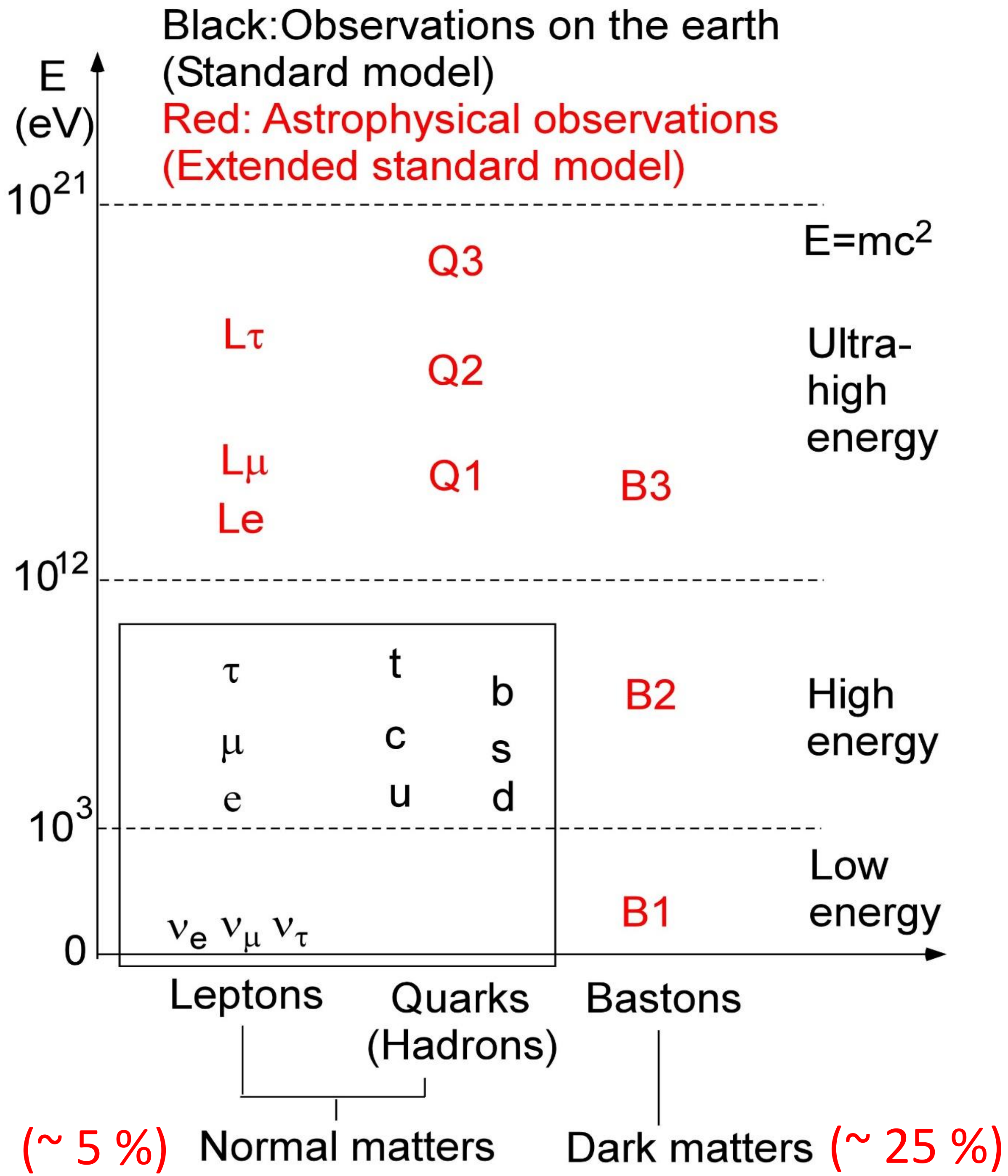


Observable (weak)

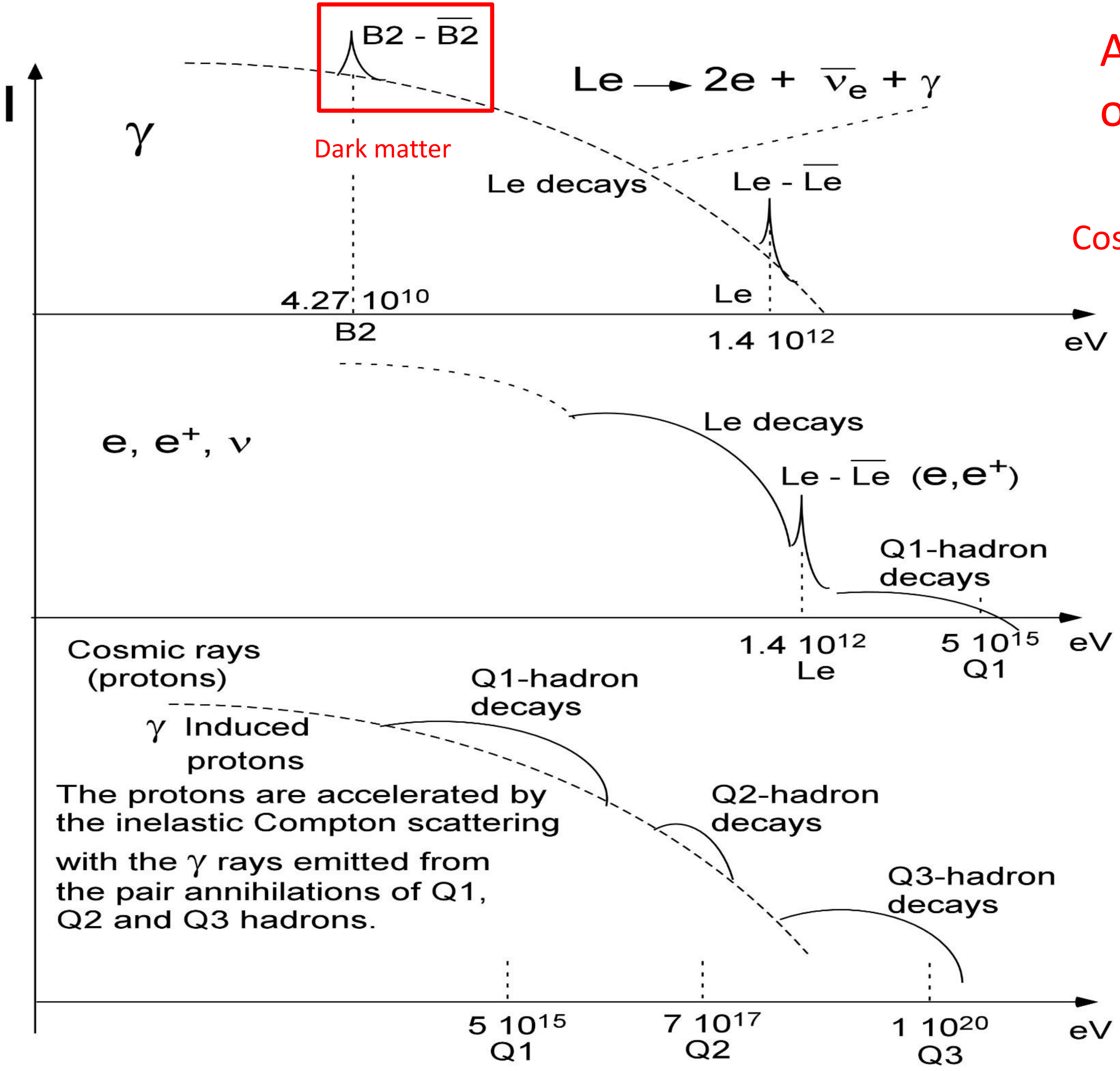
$Z(0) \longleftrightarrow Z(0,0) \longleftrightarrow Z(0,0,0)$: Force carrying bosons

$\gamma(0) \not\longleftrightarrow \gamma(0,0) \not\longleftrightarrow \gamma(0,0,0)$: Charge dependent photons

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


Black:Observations on the earth
(Standard model)
Red: Astrophysical observations
(Extended standard model)
E (eV)
10^{21}
$E=mc^2$
Q3
Lτ
Q2
Ultra-high energy
Lμ
Q1
B3
Le
10^{12}
τ
t
b
B2
High energy
μ
c
s
e
u
d
10^3
Low energy
B1
ν_e ν_μ ν_τ
0
Leptons
Quarks (Hadrons)
Bastons
(~ 5 %)
Normal matters
Dark matters
(~ 25 %)

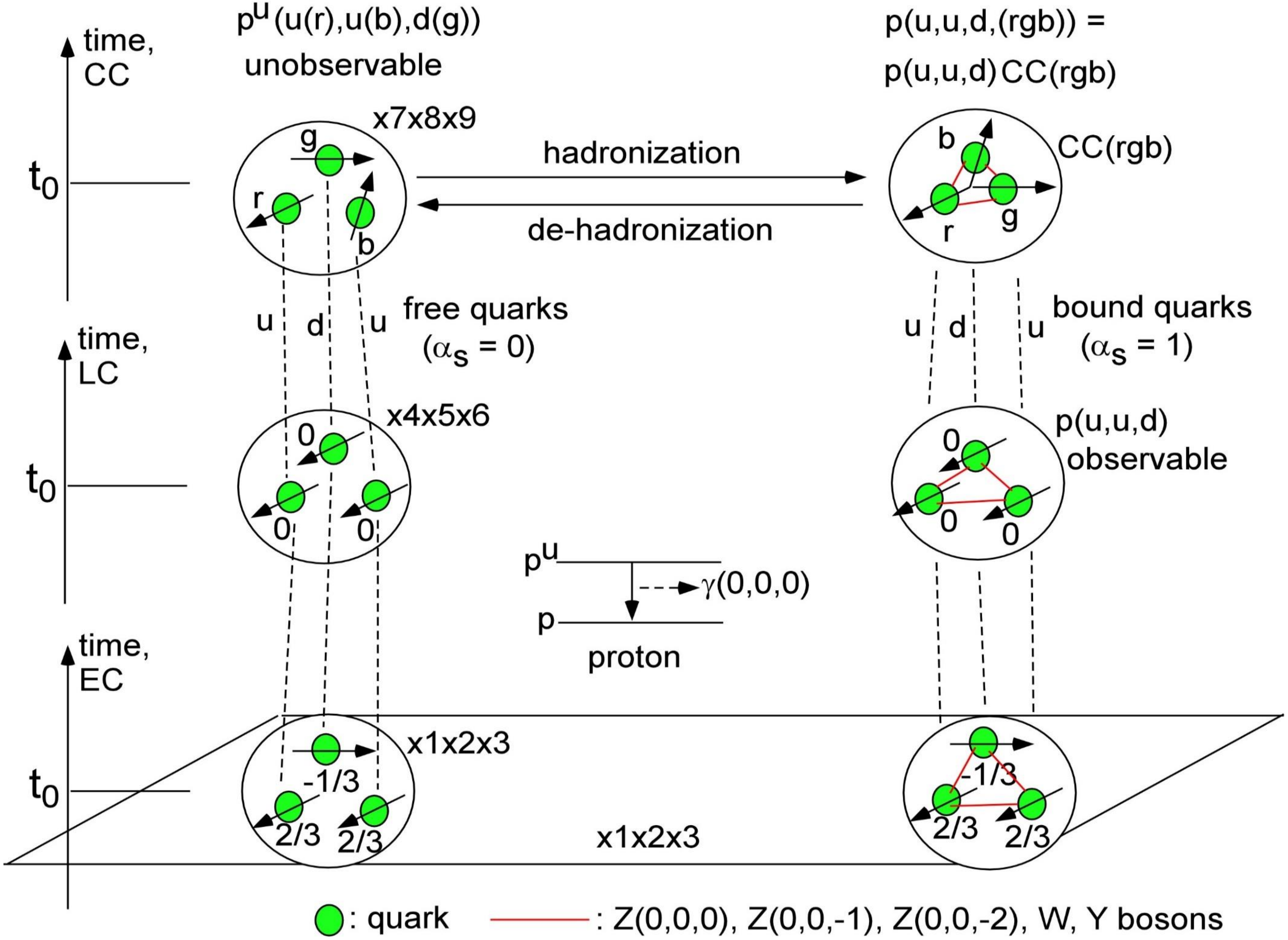
Astrophysical observations



Cosmic gamma rays

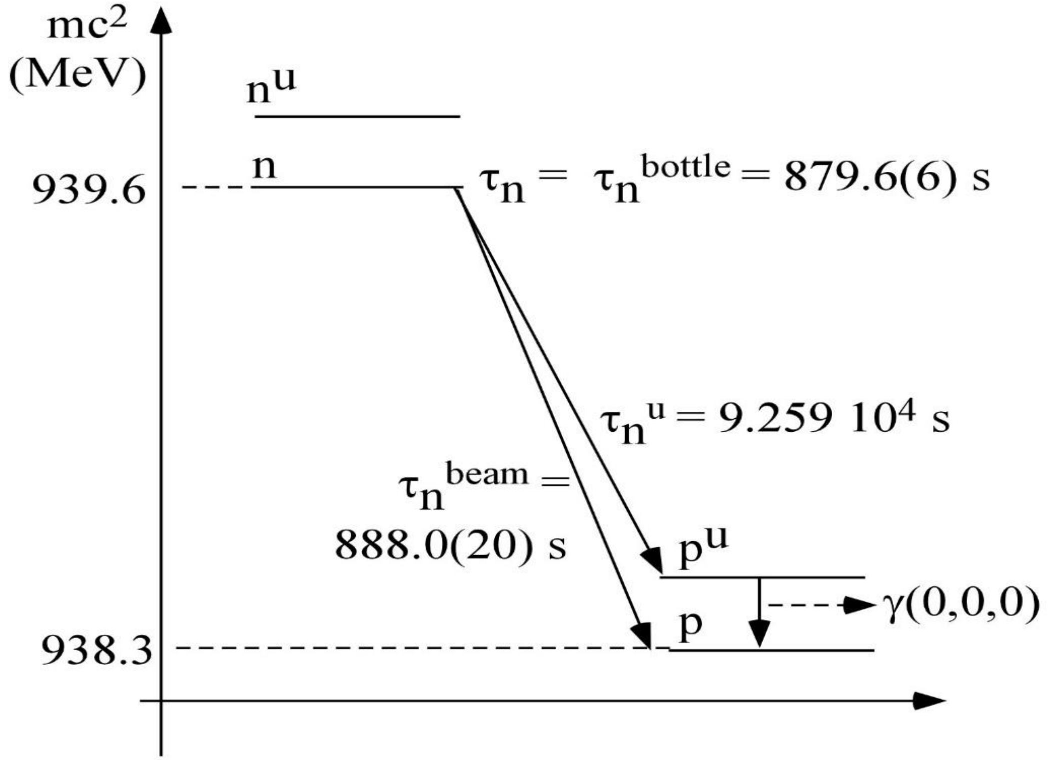
High energy cosmic rays

Ultra-high energy cosmic rays



time, CC
time, LC
time, EC
t_0
$p^u(u(r),u(b),d(g))$
unobservable
x7x8x9
hadronization
de-hadronization
$p(u,u,d,(rgb)) =$
$p(u,u,d)\,CC(rgb)$
CC(rgb)
g r b
u d u
free quarks
(α_s = 0)
bound quarks
(α_s = 1)
x4x5x6
p(u,u,d)
observable
0 0 0
p^u
$\gamma(0,0,0)$
p
proton
x1x2x3
-1/3
2/3 2/3
x1x2x3
: quark
: Z(0,0,0), Z(0,0,-1), Z(0,0,-2), W, Y bosons

neutron lifetime anomaly



$$n \to p + e + \overline{\nu}_e \qquad 99.05\ \%$$

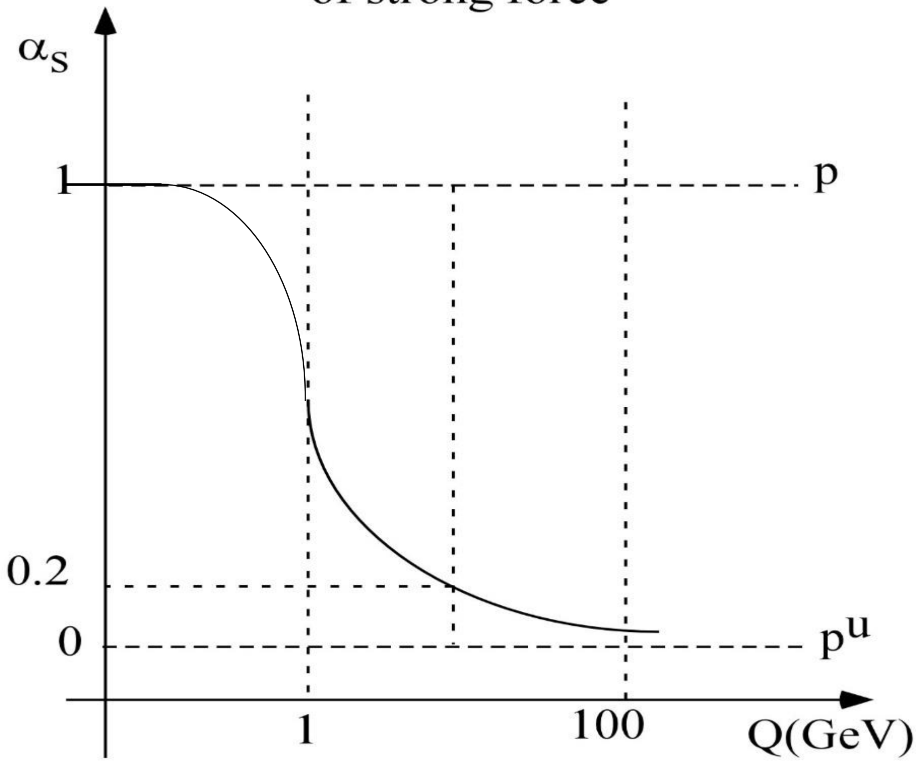
$$n \to p^u + e + \overline{\nu}_e \qquad 0.95\ \%$$

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.

B. Fornal, B. Grinstein, arXiv:1801.01124

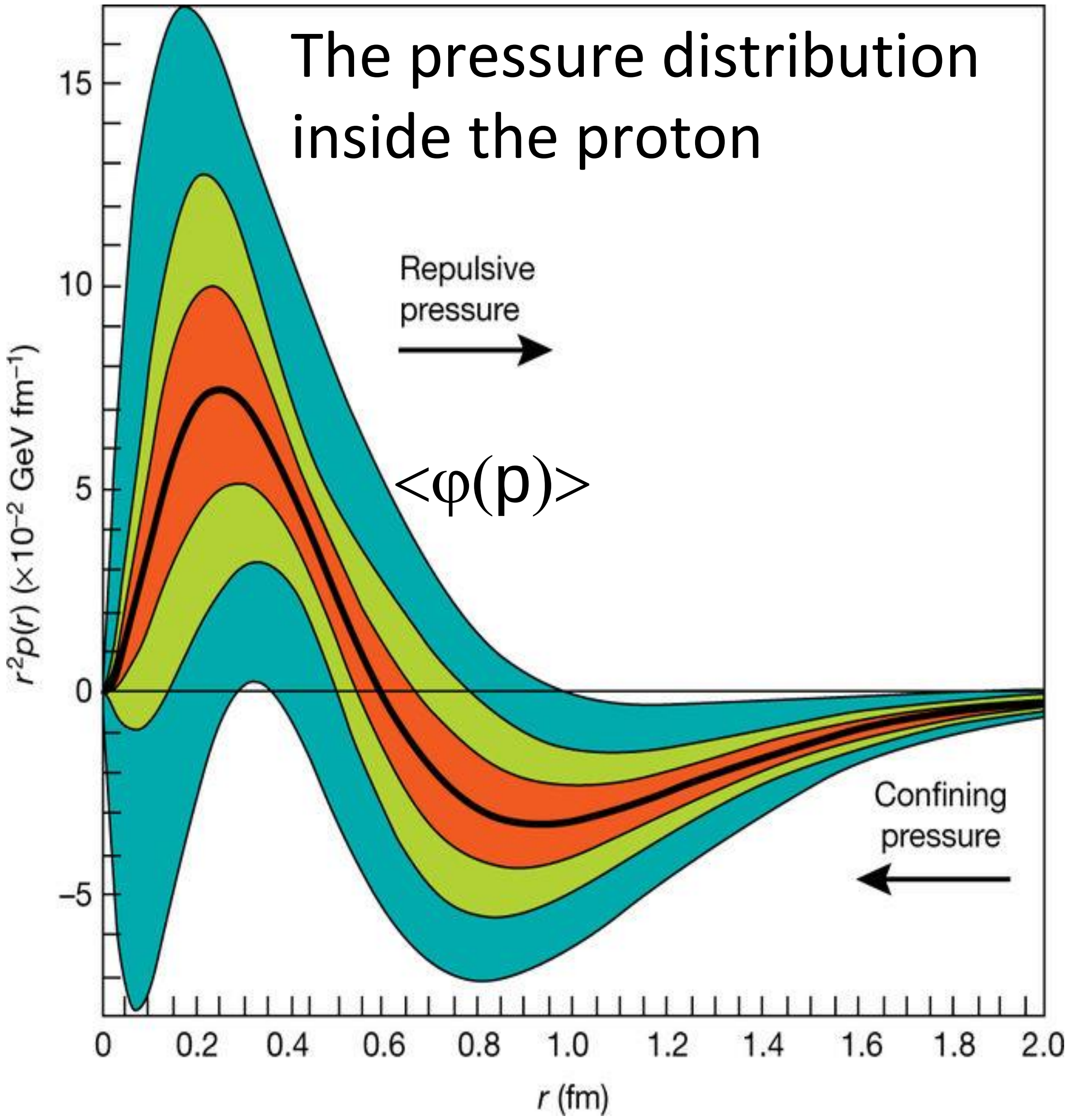
coupling constant of strong force



$$<\alpha_S> = \frac{N(p)}{N(p) + N(p^u)} = 0.2$$

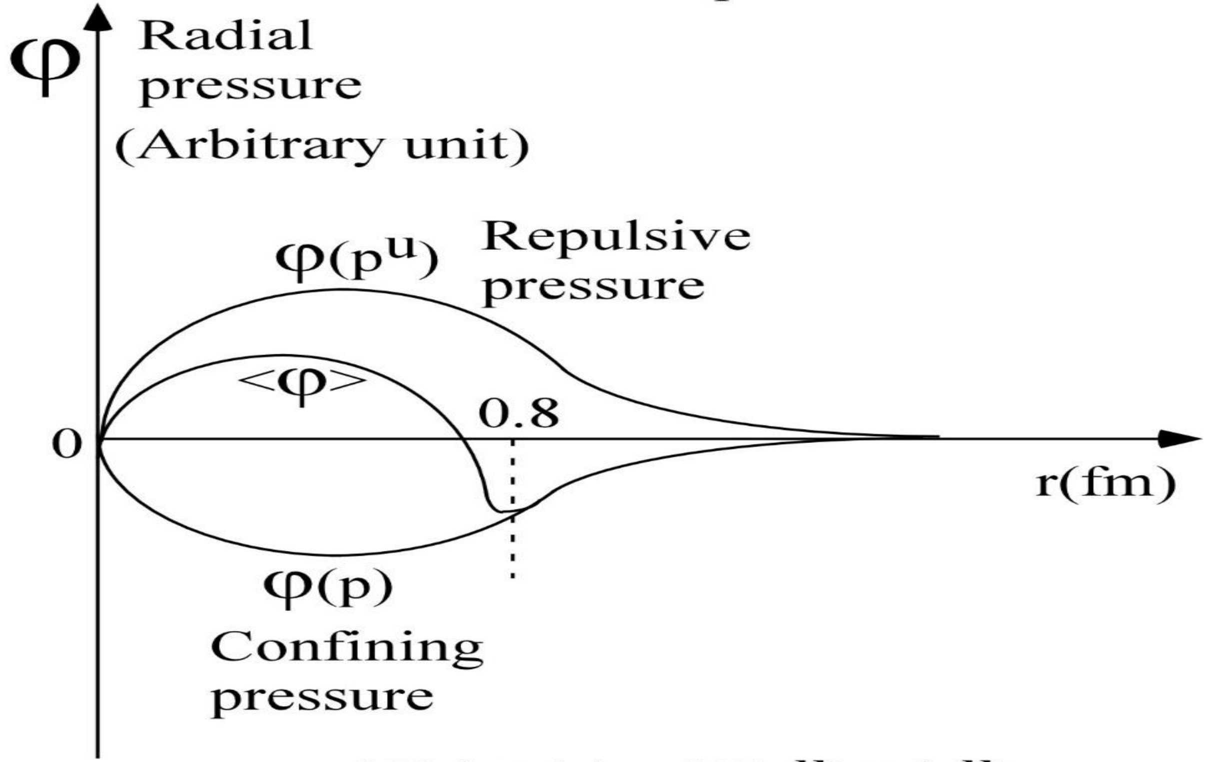
Q: momentum transfered to quarks in deep inelastic scattering experiments

S. Bethke, arXiv:hep-ex/0606035



V.D. Burkert et al., Nature 557, 396 (2018)

The pressure distribution
inside the proton



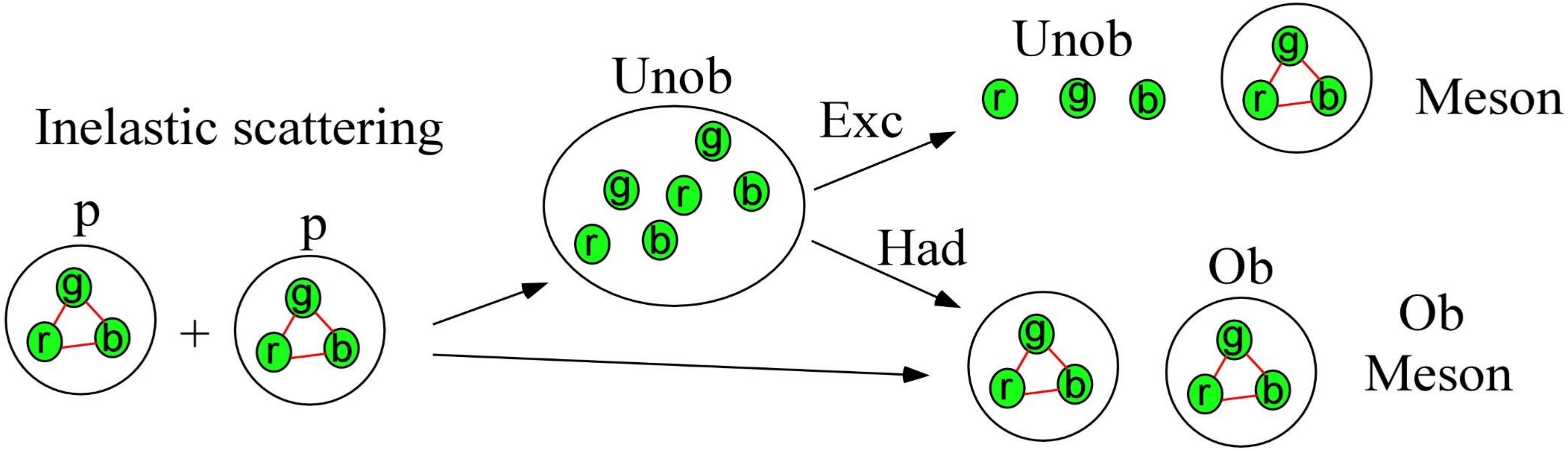
$$\langle\varphi\rangle = \frac{N(p)\varphi(p) + N(p^u)\varphi(p^u)}{N(p) + N(p^u)}$$

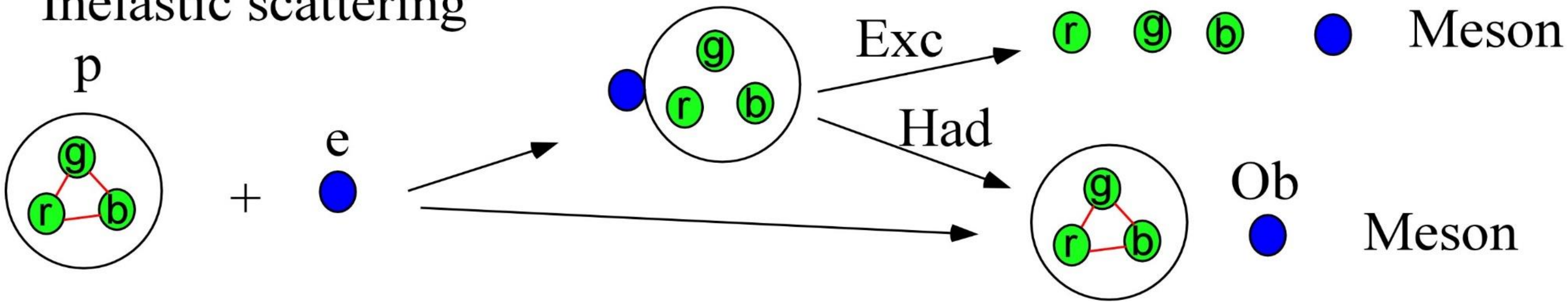
The pressure curves are plotted only for the explanation.

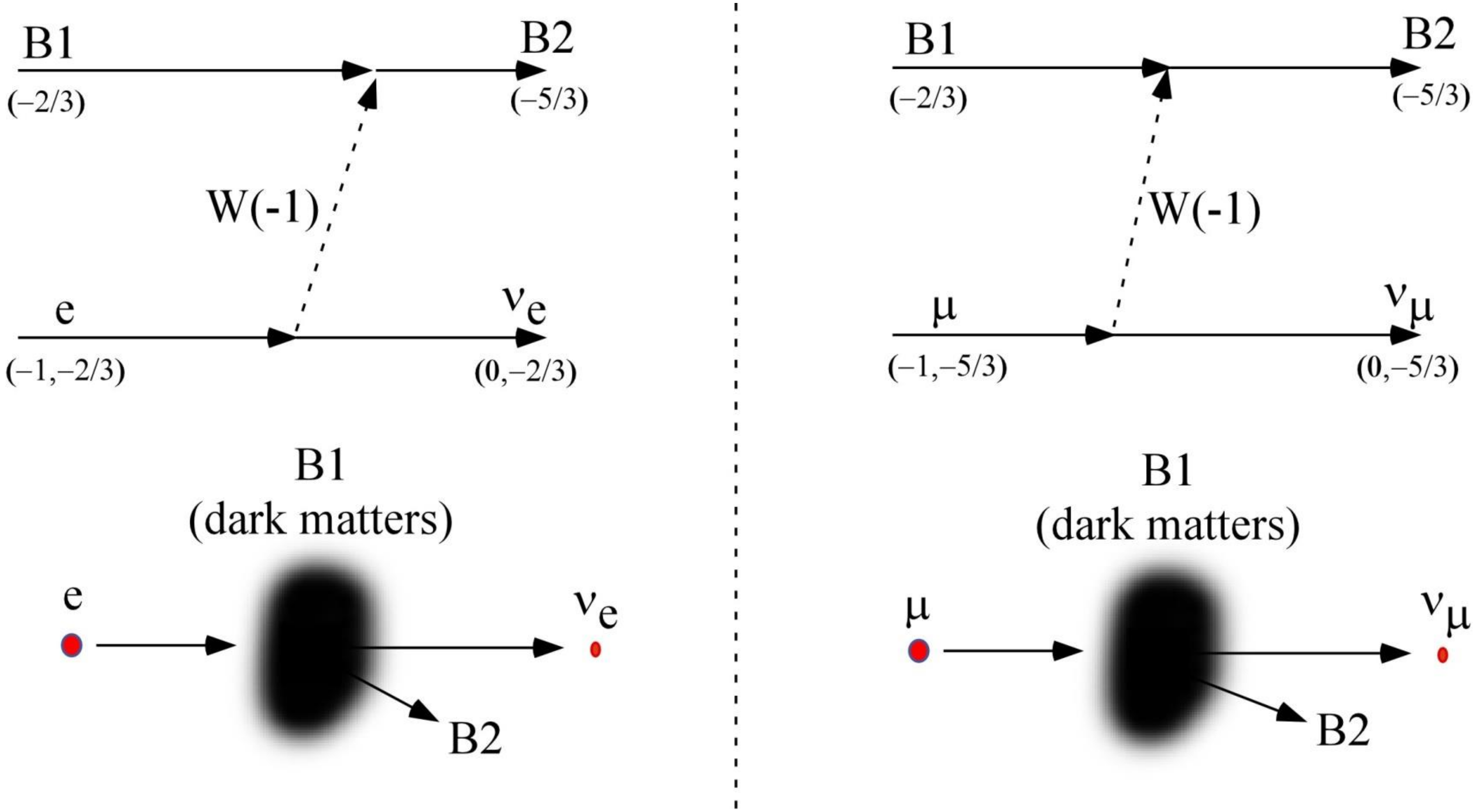
The $\langle\varphi\rangle$ curve corresponds to the experimental curve.

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





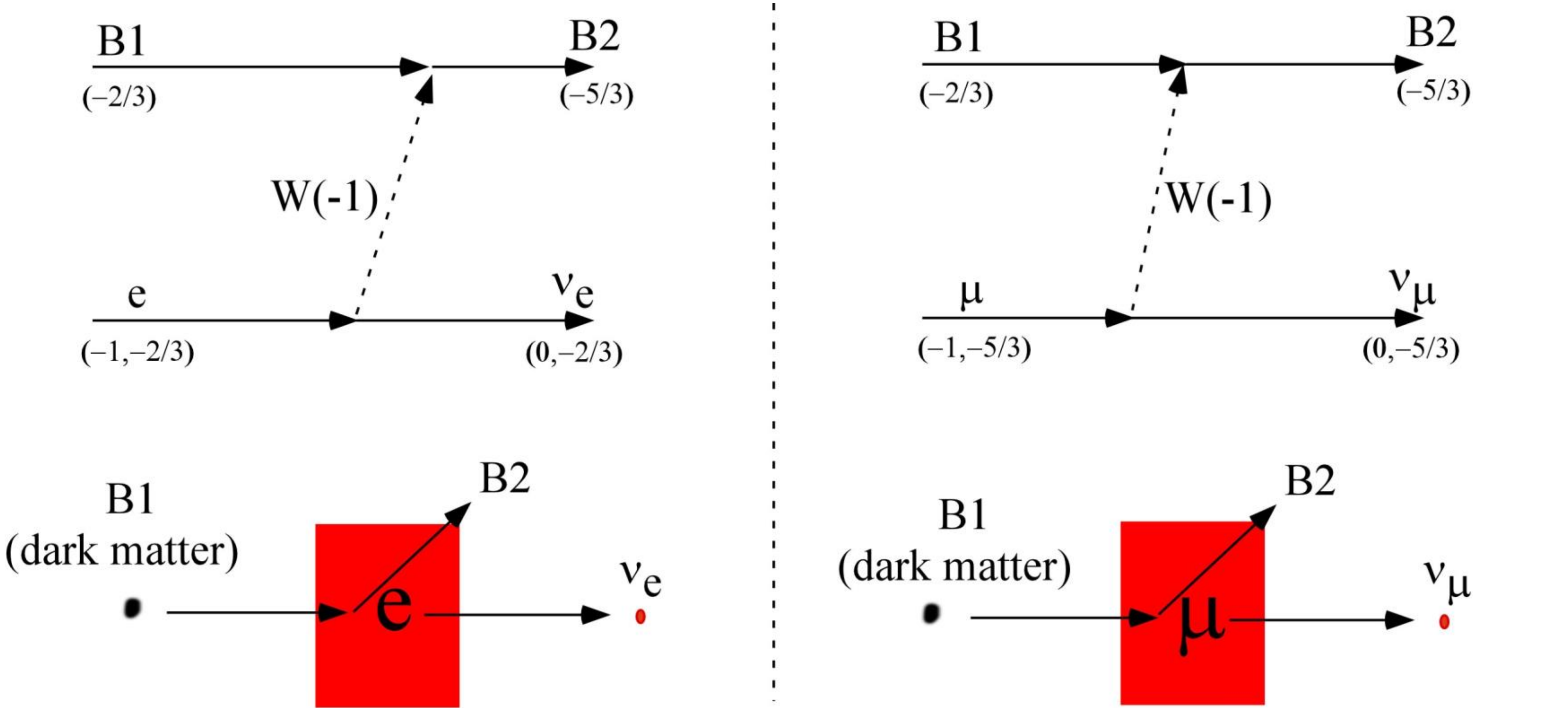


From the B1 –e and B1-μ reactions, the cosmic e and μ particles are transferred to the cosmic ν_e and ν_μ neutrinos, respectively.

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.

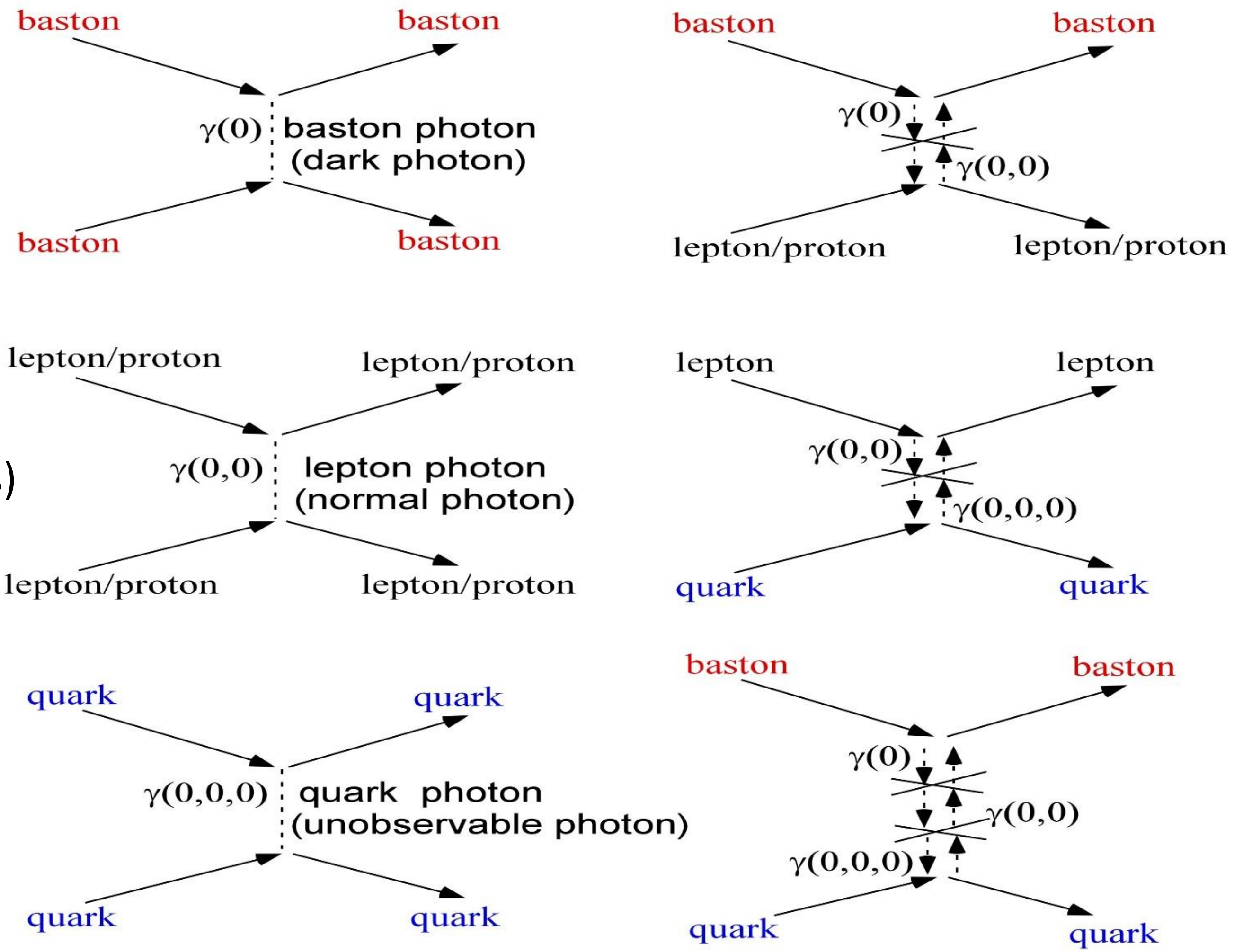
The enhanced neutrino observation is the indirect evidence of the B1 and B2 dark matters produced at LHC.

Charge forces through the photons of $\gamma(0)$, $\gamma(0,0)$ and $\gamma(0,0,0)$

Dark matters (Bastons)

Normal matters (Leptons, Baryons, Mesons)

Unobservable Matters (Quarks)



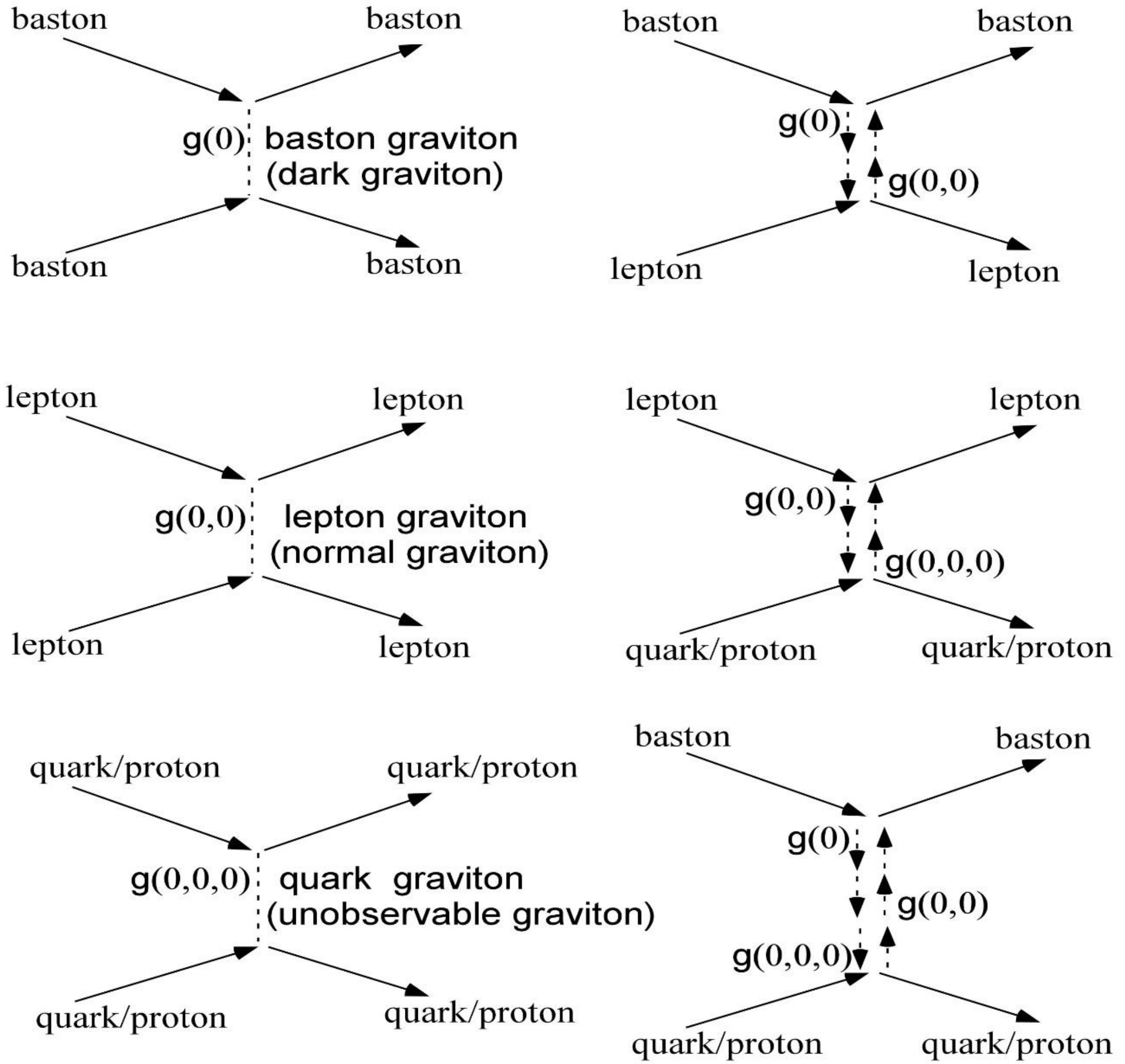
$Z(0) \longleftrightarrow Z(0,0) \longleftrightarrow Z(0,0,0)$: Force carrying bosons

$\gamma(0) \not\longleftrightarrow \gamma(0,0) \not\longleftrightarrow \gamma(0,0,0)$: Charge dependent photons

$g(0) \longleftrightarrow g(0,0) \longleftrightarrow g(0,0,0)$: 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

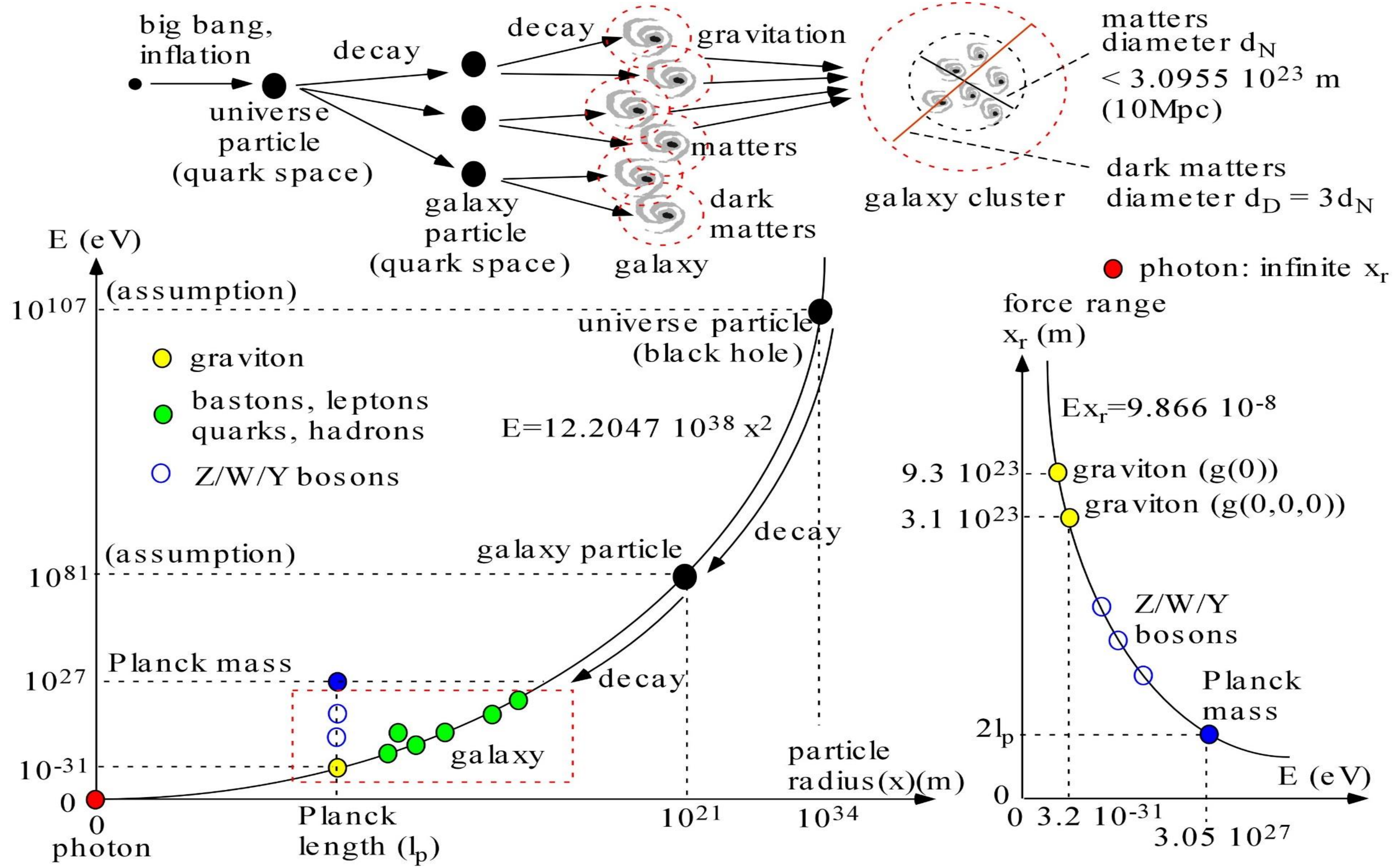
$\gamma(0) \not\longleftrightarrow \gamma(0,0) \not\longleftrightarrow \gamma(0,0,0)$: Charge dependent photons

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

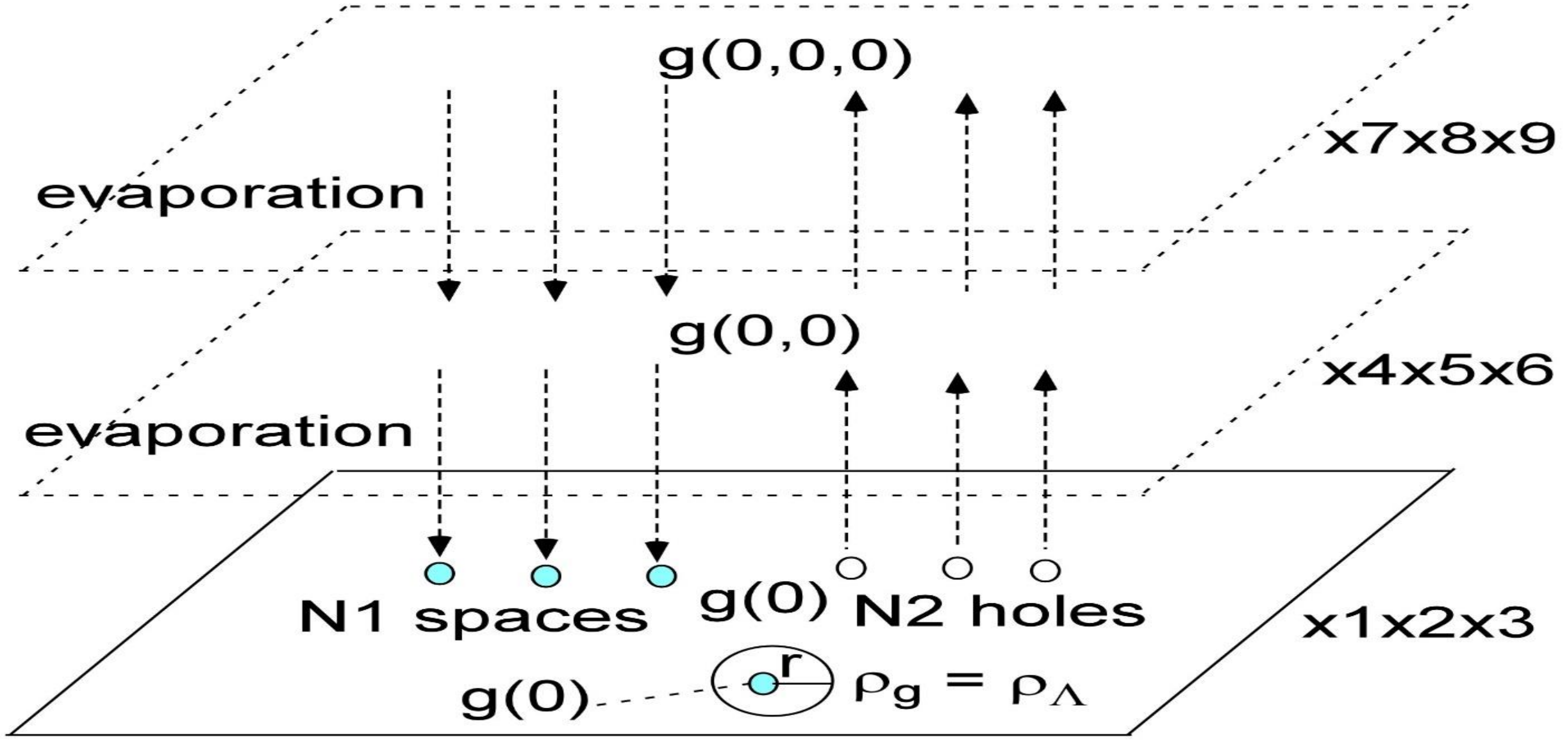
The baryons and mesons interact with the g(0,0,0) quark graviton.

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 $E = 8.1365\ 10^{38}\ x^2$ for the leptons (ν_e, ν_μ, ν_τ, e, μ, τ) and $E = 12.2047\ 10^{38}\ x^2$ for the quarks, baryons and mesons based on the measured size and energy of the proton [5].

x(m)	E(eV)	particles
$8.768(69)10^{-16}$	$938.27\ 10^{6}$	p
$1.229\ 10^{-22}$	(10^{-4})	ν_e, ν_μ, ν_τ
$2.506\ 10^{-17}$	$0.511\ 10^{6}$	e
$3.604\ 10^{-16}$	$105.7\ 10^{6}$	μ
$1.478\ 10^{-15}$	$1.777\ 10^{9}$	τ
$4.434\ 10^{-17}$	$2.4\ 10^{6}$	u
$6.271\ 10^{-17}$	$4.8\ 10^{6}$	d
$2.919\ 10^{-16}$	$104\ 10^{6}$	s
$1.020\ 10^{-15}$	$1.27\ 10^{9}$	c
$1.855\ 10^{-15}$	$4.2\ 10^{9}$	b
$1.184\ 10^{-14}$	$171.2\ 10^{9}$	t
$1.616\ 10^{-35}$ (Planck length)	$3.1872\ 10^{-31}$	graviton, g(0,0,0)



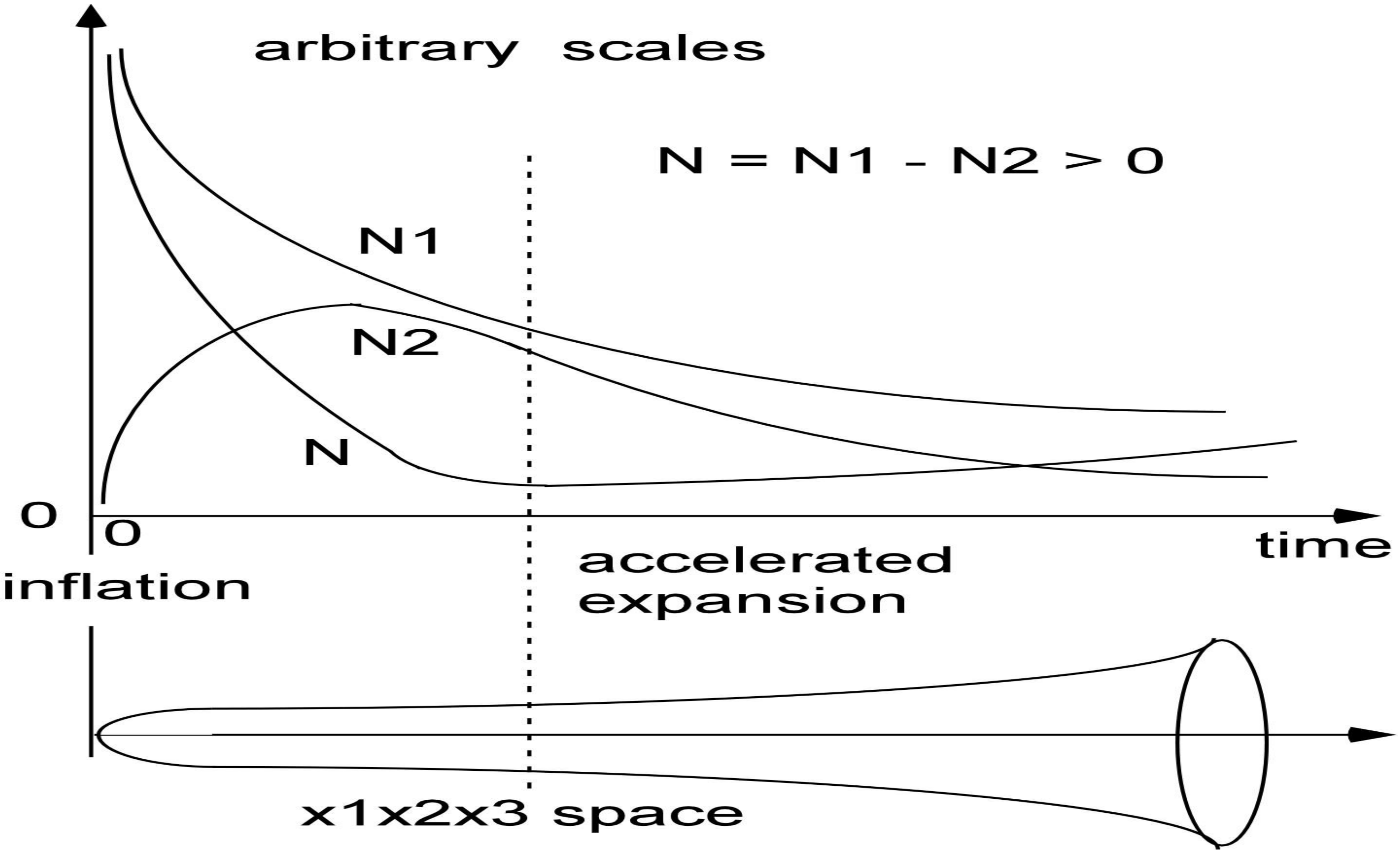
big bang, inflation
universe particle (quark space)
decay
galaxy particle (quark space)
decay
gravitation
matters
dark matters
galaxy
galaxy cluster
matters diameter d_N < 3.0955 10^{23} m (10Mpc)
dark matters diameter $d_D = 3d_N$
E (eV)
(assumption)
10^{107}
universe particle (black hole)
graviton
bastons, leptons quarks, hadrons
Z/W/Y bosons
$E=12.2047\ 10^{38}\ x^2$
decay
(assumption)
galaxy particle
10^{81}
Planck mass
10^{27}
decay
galaxy
10^{-31}
0
0
photon
Planck length (l_p)
10^{21}
10^{34}
particle radius(x)(m)
photon: infinite x_r
force range x_r (m)
$Ex_r=9.866\ 10^{-8}$
9.3 10^{23}
graviton (g(0))
3.1 10^{23}
graviton (g(0,0,0))
Z/W/Y bosons
Planck mass
$2l_p$
0
E (eV)
0 3.2 10^{-31}
3.05 10^{27}

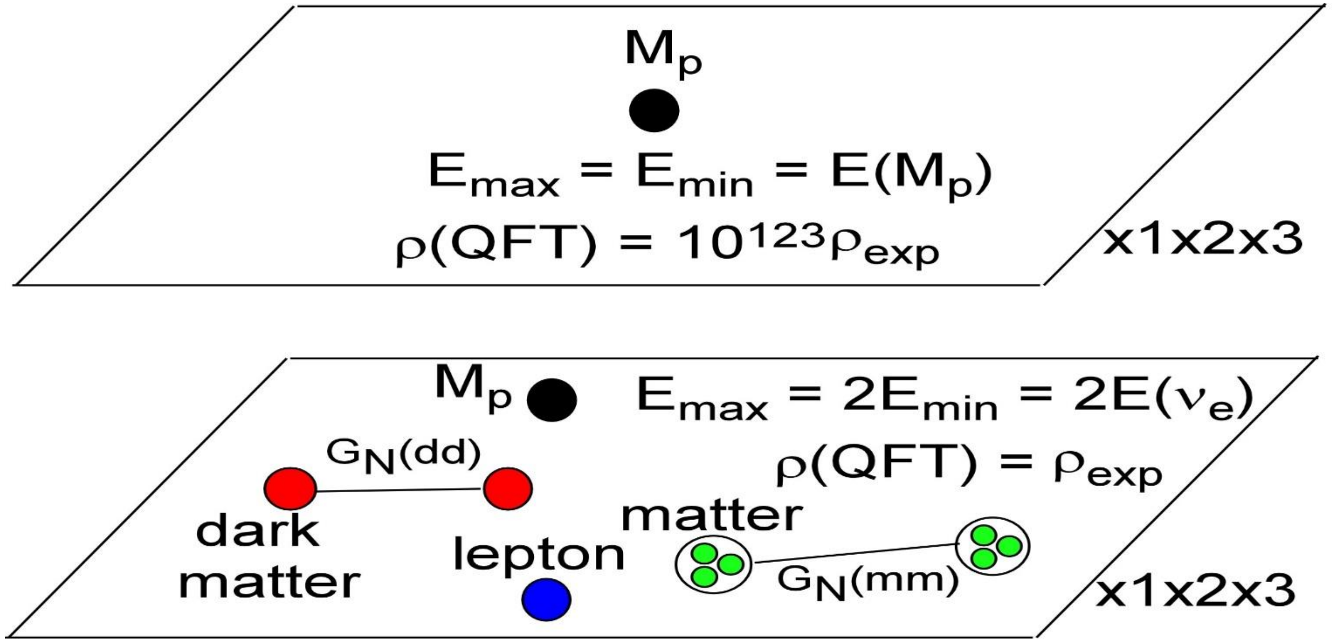


g(0) $\rightleftarrows$ g(0,0) $\rightleftarrows$ g(0,0,0): evaporation

N = N1 - N2 : number of new space quanta
x1x2x3 space expansion if N > 0.
Accelerated x1x2x3 space expansion if dN/dt > 0.

The g(0) graviton is the x1x2x3 space quantum. The energy of these g(0) gravitons is defined as the dark energy.
The g(0) energy density (ρ_g) is the same as the dark energy density (ρ_Λ) measured from WMAP.


arbitrary scales
N = N1 - N2 > 0
N1
N2
N
0
0
time
inflation
accelerated
expansion
x1x2x3 space



M_p: Planck mass

$G_N(mm) = G_N$: Newton's gravitation constant

ρ_{exp}: vacuum energy density

$\rho(QFT) = 2.64\ (E_{max})^4\ \text{erg/cm}^3$

$\rho_{exp} = 6.29\ 10^{-9}\ \text{erg/cm}^3$

E_{max}: maximum vacuum oscillation energy

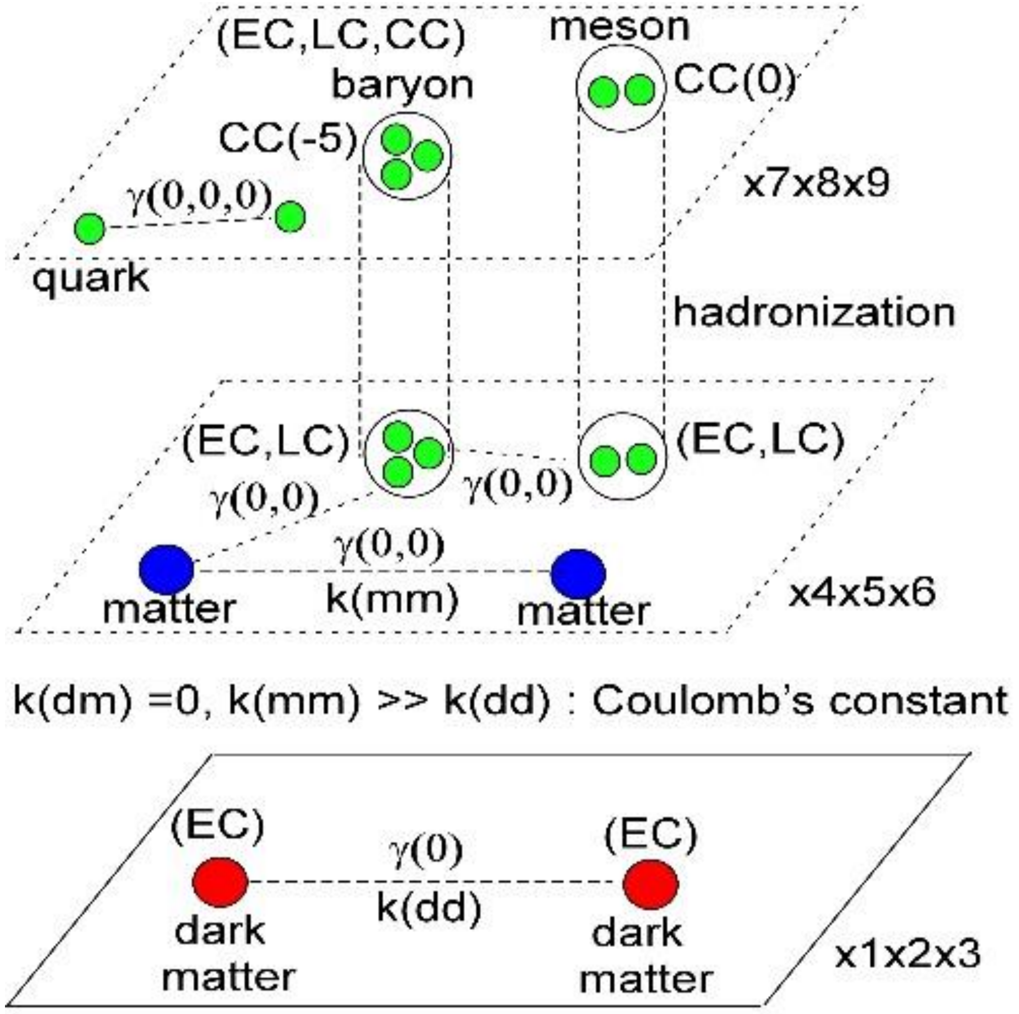
E_{min}: minimum rest mass energy of a particle

$E(\nu_e)$: rest mass energy of an electron neutrino

$E_{max} = 2E_{min} = 2E(\nu_e)$, energy unit: eV

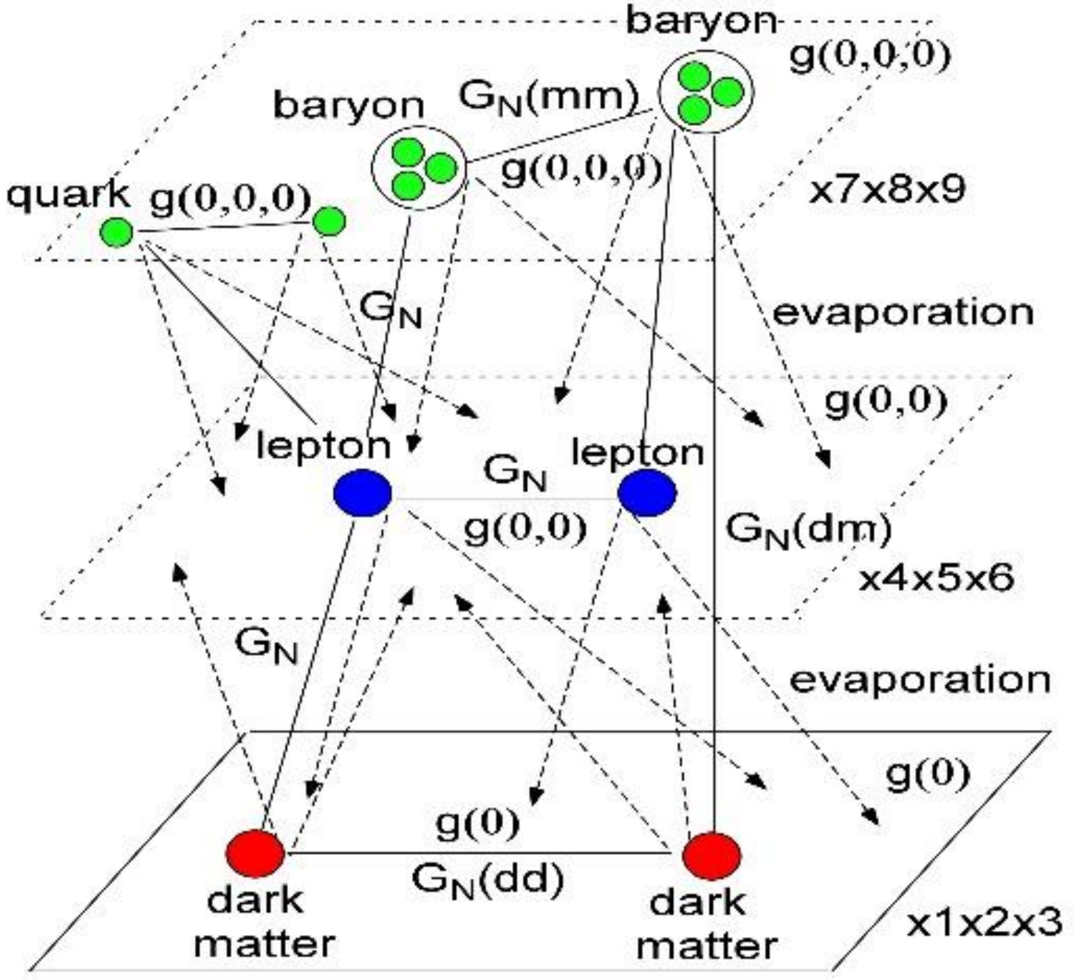
From $\rho(QFT) = \rho_{exp}$,

$E(\nu_e) = 3.494\ 10^{-3}$ eV



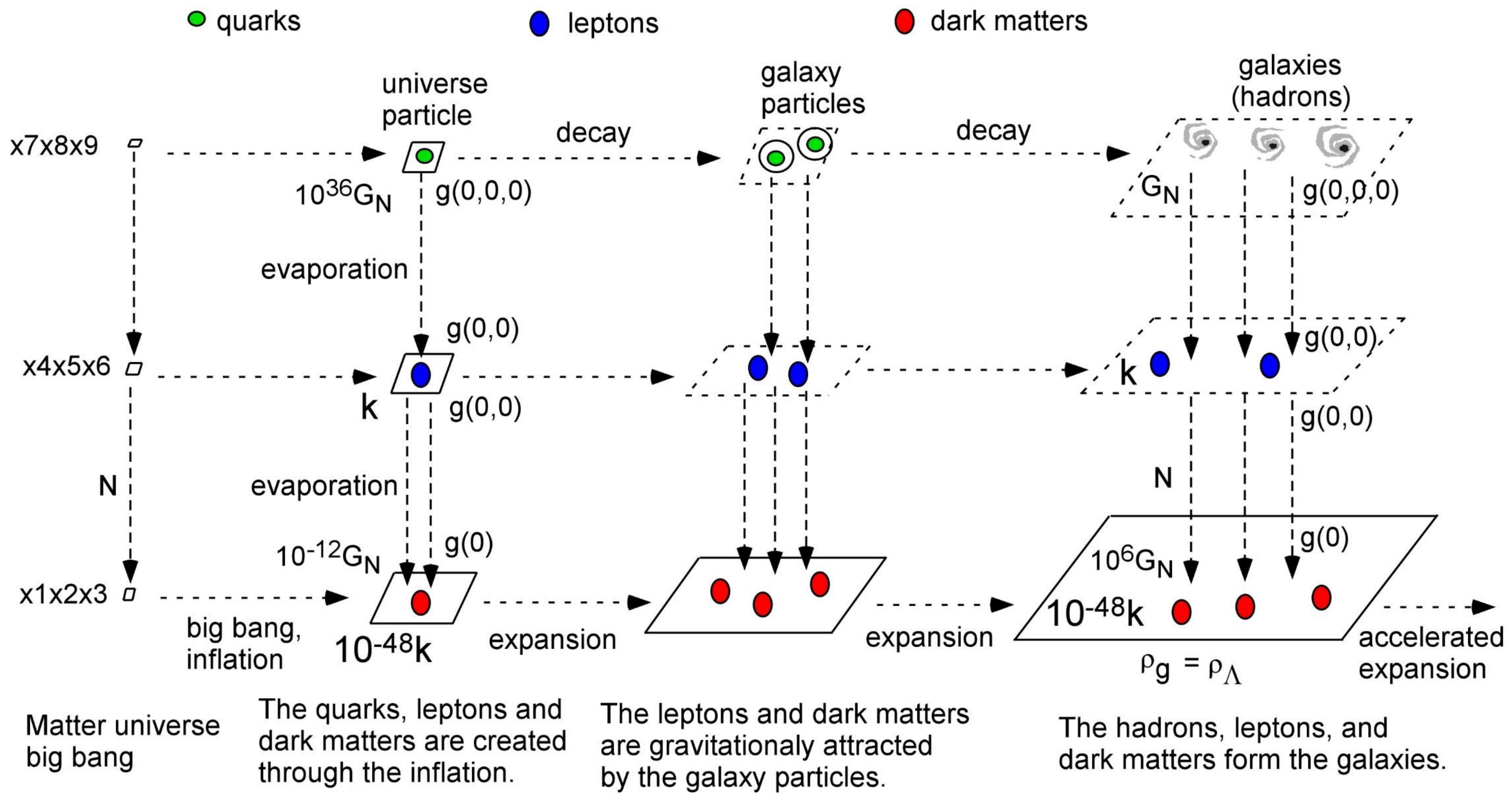
$\gamma(0) \overset{X}{\rightleftarrows} \gamma(0,0) \overset{X}{\rightleftarrows} \gamma(0,0,0)$: confinement

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

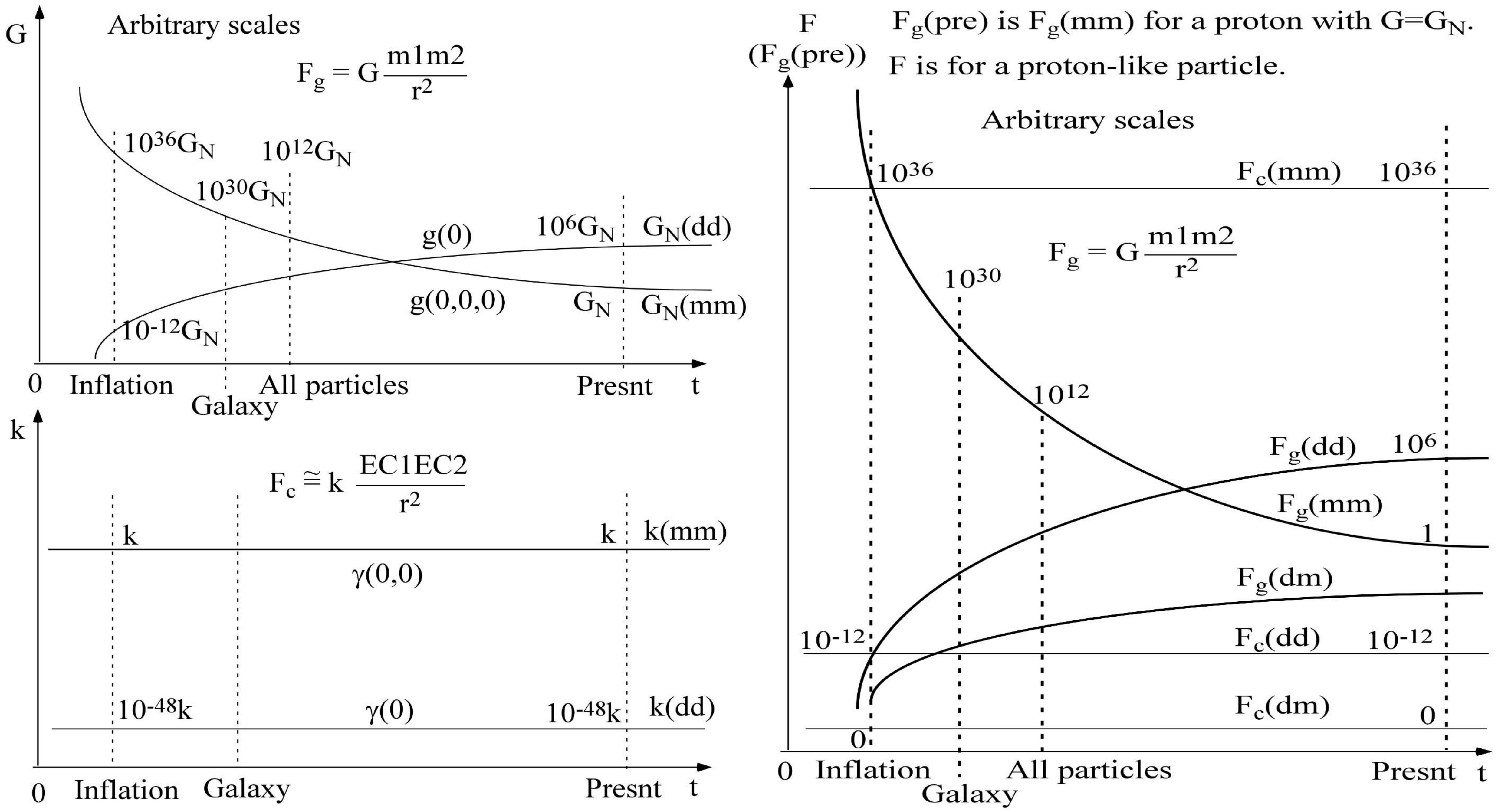


$g(0) \rightleftarrows g(0,0) \rightleftarrows g(0,0,0)$: evaporation

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



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.



G
Arbitrary scales
$F_g = G \frac{m1m2}{r^2}$
$10^{36}G_N$
$10^{12}G_N$
$10^{30}G_N$
g(0)
10^6G_N
G_N(dd)
g(0,0,0)
G_N
G_N(mm)
$10^{-12}G_N$
0
Inflation
Galaxy
All particles
Presnt
t
k
$F_c \cong k \frac{EC1EC2}{r^2}$
k
k
k(mm)
γ(0,0)
10^{-48}k
γ(0)
10^{-48}k
k(dd)
0
Inflation
Galaxy
Presnt
t
F
(F_g(pre))
F_g(pre) is F_g(mm) for a proton with $G=G_N$.
F is for a proton-like particle.
Arbitrary scales
10^{36}
F_c(mm)
10^{36}
$F_g = G \frac{m1m2}{r^2}$
10^{30}
10^{12}
F_g(dd)
10^6
F_g(mm)
1
F_g(dm)
10^{-12}
F_c(dd)
10^{-12}
F_c(dm)
0
0
0
Inflation
Galaxy
All particles
Presnt
t

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

Particles	E_p(mm), (eV)	$G = G_N(\text{mm}) = 10^x G_N$
γ	≈ 0	$\approx \infty$, Big bang
graviton	10^{-30}	$10^{116} G_N$
ν_e	10^{-2}	$10^{60} G_N$
B1	10^{2}	$10^{52} G_N$
e, u, d	10^{6}	$10^{44} G_N$
p, n	10^{10}	$10^{36} G_N$
W(-1,0), Z(0,0), Baryons, B2	10^{11}	$10^{34} G_N$
Nuclei, Atoms	10^{12}	$10^{32} G_N$
Le, Stars, Galaxies	10^{13}	$10^{30} G_N$
All elementary particles	10^{22}	$10^{12} G_N$
Present Planck mass	10^{28}	G_N, Flat space

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 10^6G_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 evolutio. 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 $G_N(mm) \approx 10^{36}G_N$, and $G_N(dd) = 10^{-12}G_N$ 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 $G_N(mm) \approx 10^{36}G_N$. It can be assumed that at the present time, $G_N(mm) = G_N$, and $G_N(dd) \approx 10^{6}G_N$ 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 $G_N(mm) \approx G_N$. And, it can be assumed that always $k(mm) = k \approx 10^{48}k(dd)$.

At the present time, $F_g(mm) = 8\ 10^{-37}F_c(mm) \approx 10^{-36}F_c(mm)$ for the proton. $F_c = F_c(EC) + F_c(LC) + F_c(CC) \approx F_c(EC) = k\,\frac{EC1EC2}{r^2}$ 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 $F_c(mm) \approx 10^{36}F_g(mm)$, $F_g(dd) = 10^6F_g(mm)$ 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)

	Dark matter force				Weak force (EC,LC)				Strong force (EC,LC,CC)			
	EC				EC				EC			
X1	0	Z(0)			0	Z(0,0)	Z(0,–1)	Z(0,–2)	0	Z(0,0)	Z(0,–1)	Z(0,–2)
X2	-1	W(-1)			-1	W(-1,0)	W(-1,-1)	W(-1,-2)	-1	W(-1,0)	W(-1,-1)	W(-1,-2)
X3	-2	Y(-2)			-2	Y(-2,0)	Y(-2,-1)	Y(-2,-2)	-2	Y(-2,0)	Y(-2,-1)	Y(-2,-2)
Total	-3				-3				-3			
					LC				LC			
X4					0	Z(0,0)	W(–1,0)	Y(–2,0)	0	Z(0,0)	W(–1,0)	Y(–2,0)
X5					-1	Z(0,-1)	W(-1,-1)	Y(-1,-1)	-1	Z(0,-1)	W(-1,-1)	Y(-1,-1)
X6					-2	Z(0,-2)	W(-1,-2)	Y(-2,-2)	-2	Z(0,-2)	W(-1,-2)	Y(-2,-2)
Total					-3				-3			
									CC			
X7									0			
X8									-1			
X9									-2			
Total									-3			

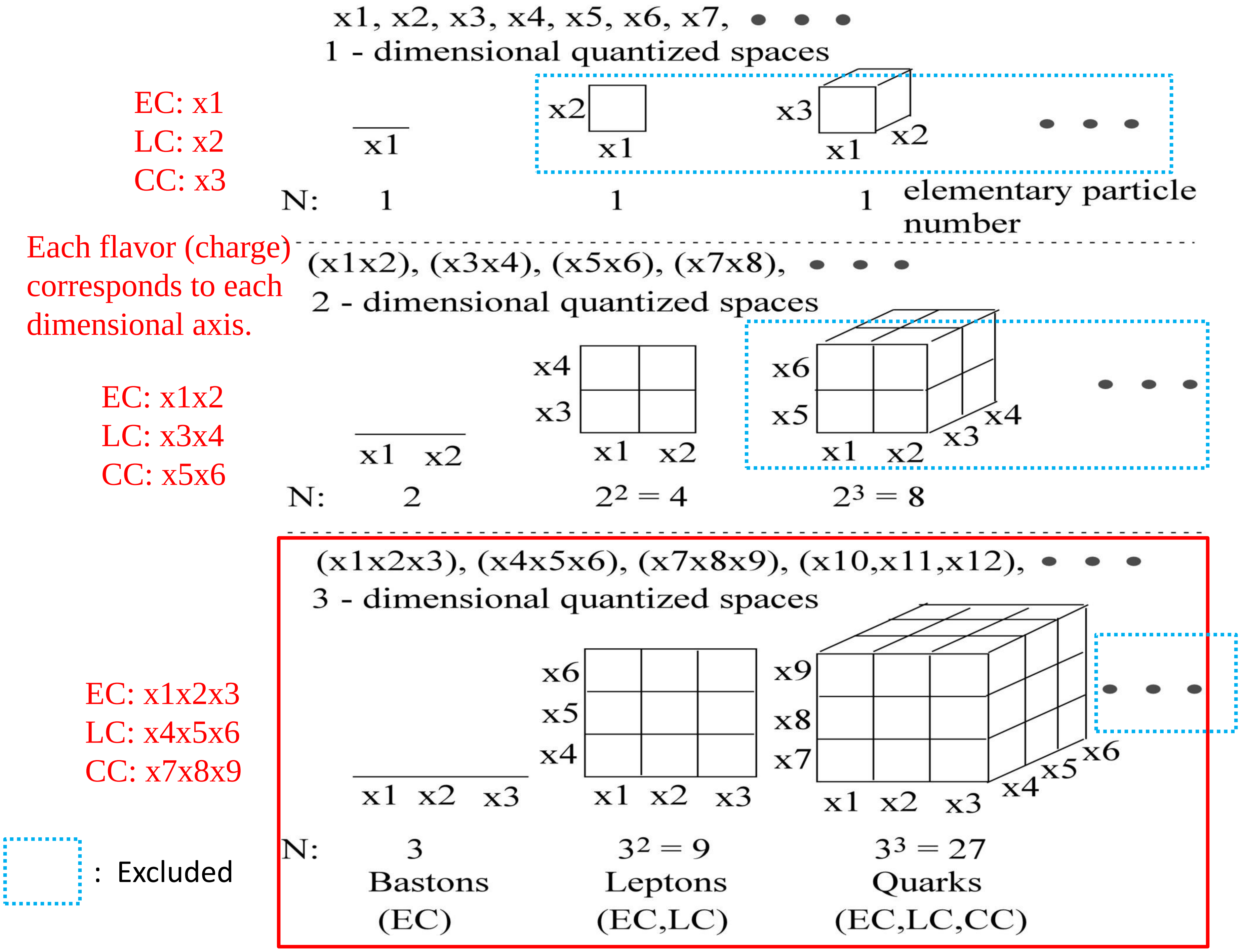
Z, W^-, gluons (SM) →
Z(0,LC),W(-1,LC), Z(0,0,CC) (ESM)

Z/W/Y(EC,LC,0) ⟷ Z/W/Y(EC,LC)
Z/W/Y(EC,0) ⟷ Z/W/Y(EC)

Z/W/Y(-1,0)CC(-2) = Z/W/Y(-1,0,-2)

SM		Leptons, Mesons, Baryons (EC)	Quarks (EC,CC)
Long Range Force (EM Force), Photon		F(EC), QED, γ	
Short Range Force		Weak Force Massive bosons (Z, W^+, W^-) (EC)	Strong Force, QCD, Massless gluons (CC)
ESM (TQSM)	Bastons (EC) (Dark matters)	Leptons, Mesons, Baryons (EC,LC))	Quarks (EC,LC,CC)
Long Range Force (EM Force), Photon QED	F(EC), Dark photon $\gamma(0)$	F(EC,LC) = F(EC)+F(LC) Normal photon $\gamma(0,0)$	F(EC,LC,CC) = F(EC)+F(LC)+F(CC) Unobservable photon $\gamma(0,0,0)$
Short Range Force Massive bosons	Dark matter force Z/W/Y(EC)	Weak force Z/W/Y(EC,LC)	Strong force Z/W/Y(EC,LC,CC)

SM: Standard Model, ESM: Extended Standard Model,
TQSM: Three-dimensional Quantized Space Model, QED: Quantum Eletro-Dynamics,
QCD: Quantum Chromo-Dynamics, EM Force: Electro-Magnetic Force
In SM, the force corresponding to the lepton charges (LC) is not considered.

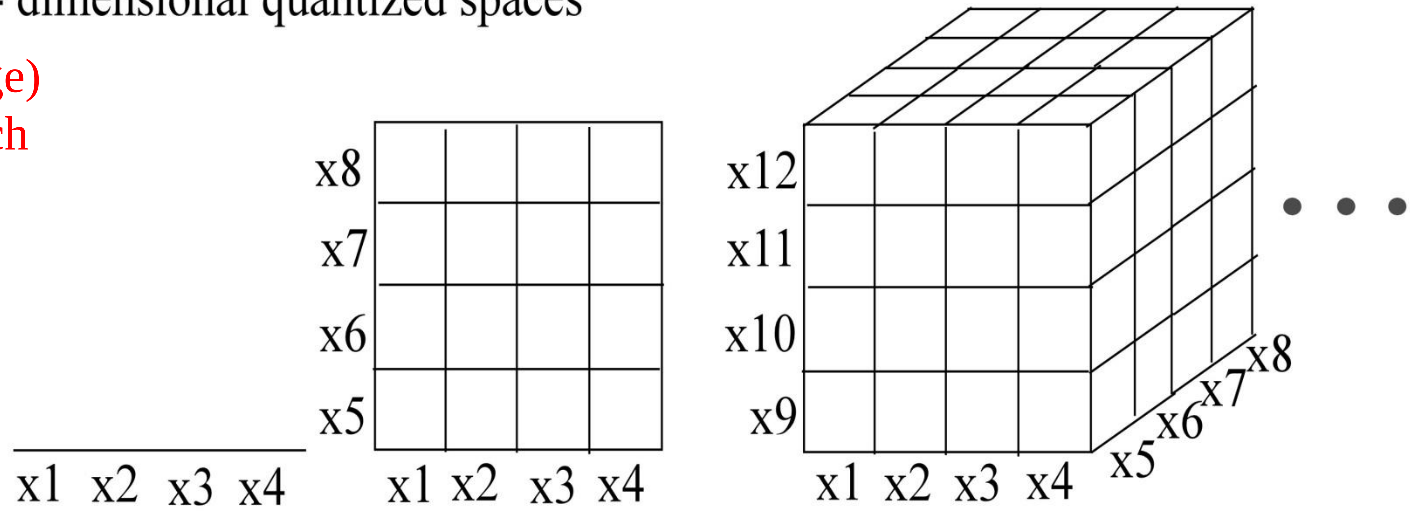

x1, x2, x3, x4, x5, x6, x7, • • •
1 - dimensional quantized spaces
EC: x1
LC: x2
CC: x3
x1
x2
x1
x3
x1
x2
• • •
N: 1 1 1 elementary particle number
Each flavor (charge) corresponds to each dimensional axis.
(x1x2), (x3x4), (x5x6), (x7x8), • • •
2 - dimensional quantized spaces
EC: x1x2
LC: x3x4
CC: x5x6
x1 x2
x4
x3
x1 x2
x6
x5
x1 x2 x3 x4
• • •
N: 2 2² = 4 2³ = 8
(x1x2x3), (x4x5x6), (x7x8x9), (x10,x11,x12), • • •
3 - dimensional quantized spaces
EC: x1x2x3
LC: x4x5x6
CC: x7x8x9
x1 x2 x3
x6
x5
x4
x1 x2 x3
x9
x8
x7
x1 x2 x3 x4 x5 x6
• • •
N: 3 3² = 9 3³ = 27
Bastons
(EC)
Leptons
(EC,LC)
Quarks
(EC,LC,CC)
: Excluded

(x1x2x3x4), (x5x6x7x8), (x9x10x11x12), • • •

4 - dimensional quantized spaces

Each flavor (charge) corresponds to each dimensional axis.

EC: x1x2x3x4
LC: x5x6x7x8
CC: x9x10x11x12



N: 4 $4^2 = 16$ $4^3 = 64$

(x1, x2, x3, x4, x5, x6, x7, • • •), • • •

n - dimensional quantized spaces

N:	n	n^2	n^3	elementary particle number
	(EC)	(EC,LC)	(EC,LC,CC)	

Unquantized space is the infinite n - dimensional quantized space with the infinite number of the EC elementary particles.

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 $10^{15\text{-}20}$ 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 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.