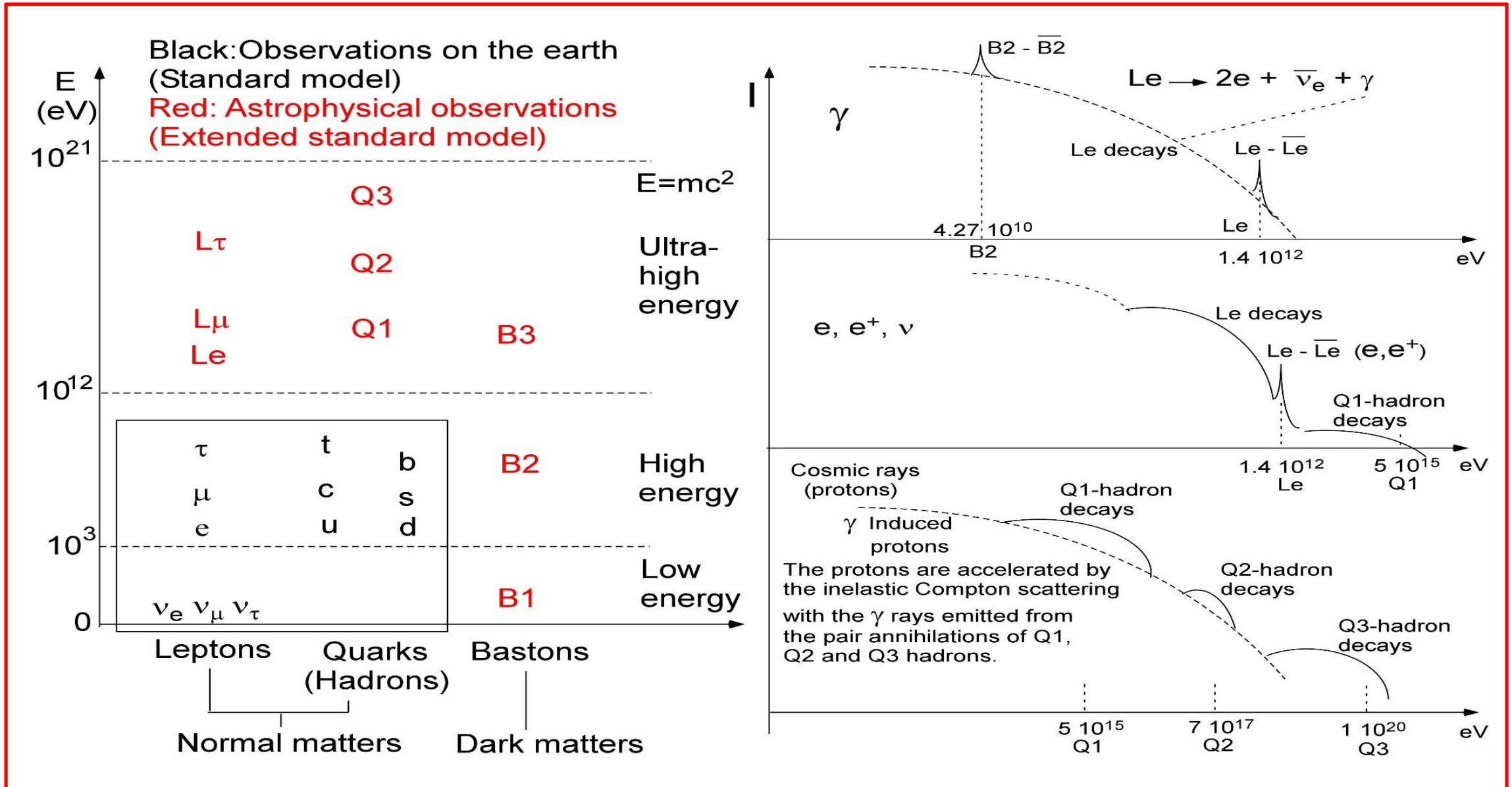


Fermionic dark matters, dark energy, massive graviton and extended standard model



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 .

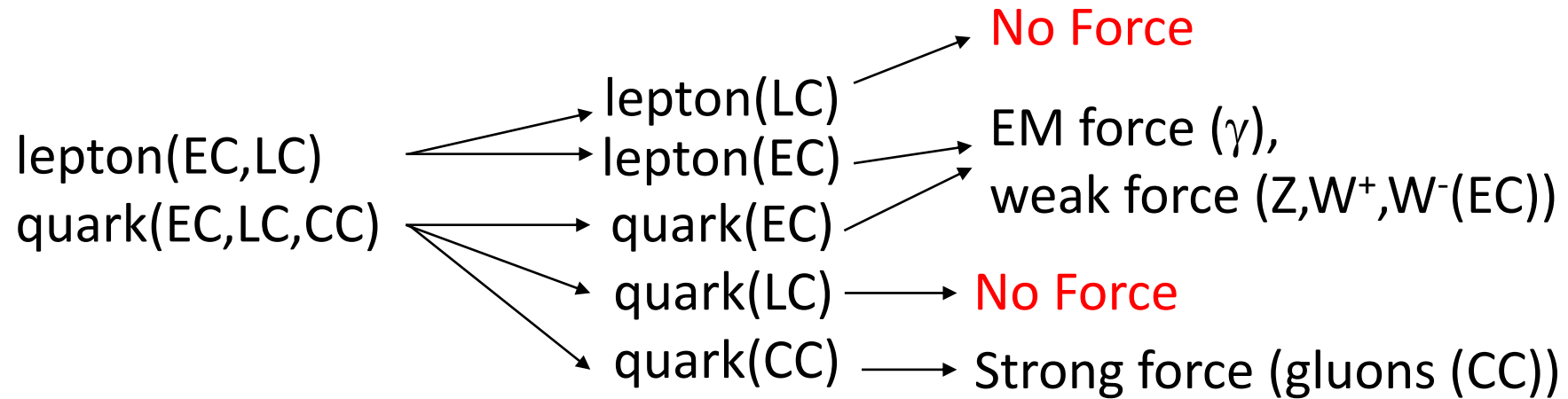
Standard model (SM)

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)	$2 \times 3^1 = 6$	$2 \times 3^2 = 18$

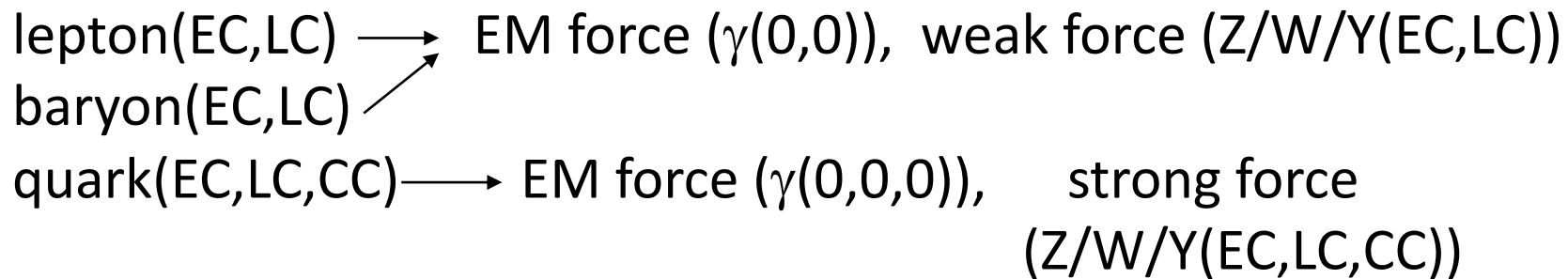
EC: Electric charge, LC: Lepton charge, CC: Color charge

1. Standard model (SM),



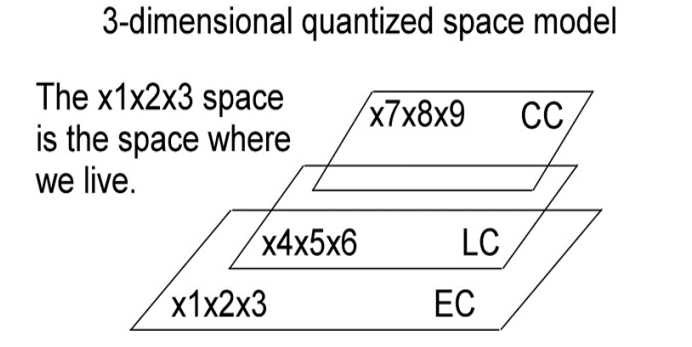
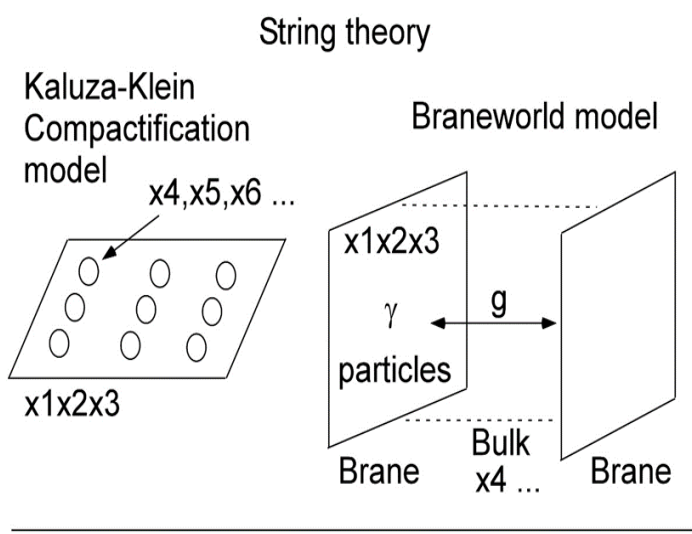
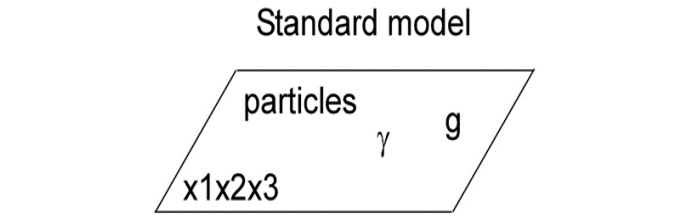
no dark matters are assigned.

2. Extended standard model (ESM),



baston(EC) \longrightarrow EM force ($\gamma(0)$), dark matter force (Z/W/Y(EC))
(dark matter)

	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	L μ	L τ	-4/3	Q1	Q2	Q3	
Total	-5				-3				-1				
	Dark matters				LC				LC				
X4					-2/3	ν_e	e	Le	0	u	d	Q1	
X5	-1 = 2/3 -1/3 -4/3				-5/3	ν_μ	μ	L μ	-1	c	s	Q2	
X6	-3 = 0 -1 -2				-8/3	ν_τ	τ	L τ	-2	t	b	Q3	
X6	-5 = -2/3 -5/3 -8/3												
Total					-5				-3				
	Each flavor (charge) corresponds to each dimensional axis.								CC				
X7									-2/3(r)				
X8	Force carrying bosons: EC, LC, CC = 0, -1, -2								-5/3(g)				
X9	EC, LC, CC Conservations in reactions and decays of particles								-8/3(b)				
Total									-5				



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.

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

Rest mass energy ($E=mc^2$) calculations of leptons and bastons (dark matters)

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

$$E = 11.1950 \cdot 10^{38+2F} \quad \text{for 3 bastons with } LC = 0$$

$$E = 8.1365 \cdot 10^{38+2F} \quad \text{for leptons } (\nu_e, \nu_\mu, \nu_\tau, e, \mu, \tau)$$

$$E = 0.4498 \cdot 10^{38+2F} \quad \text{for leptons } (L_e, L_\mu, L_\tau)$$

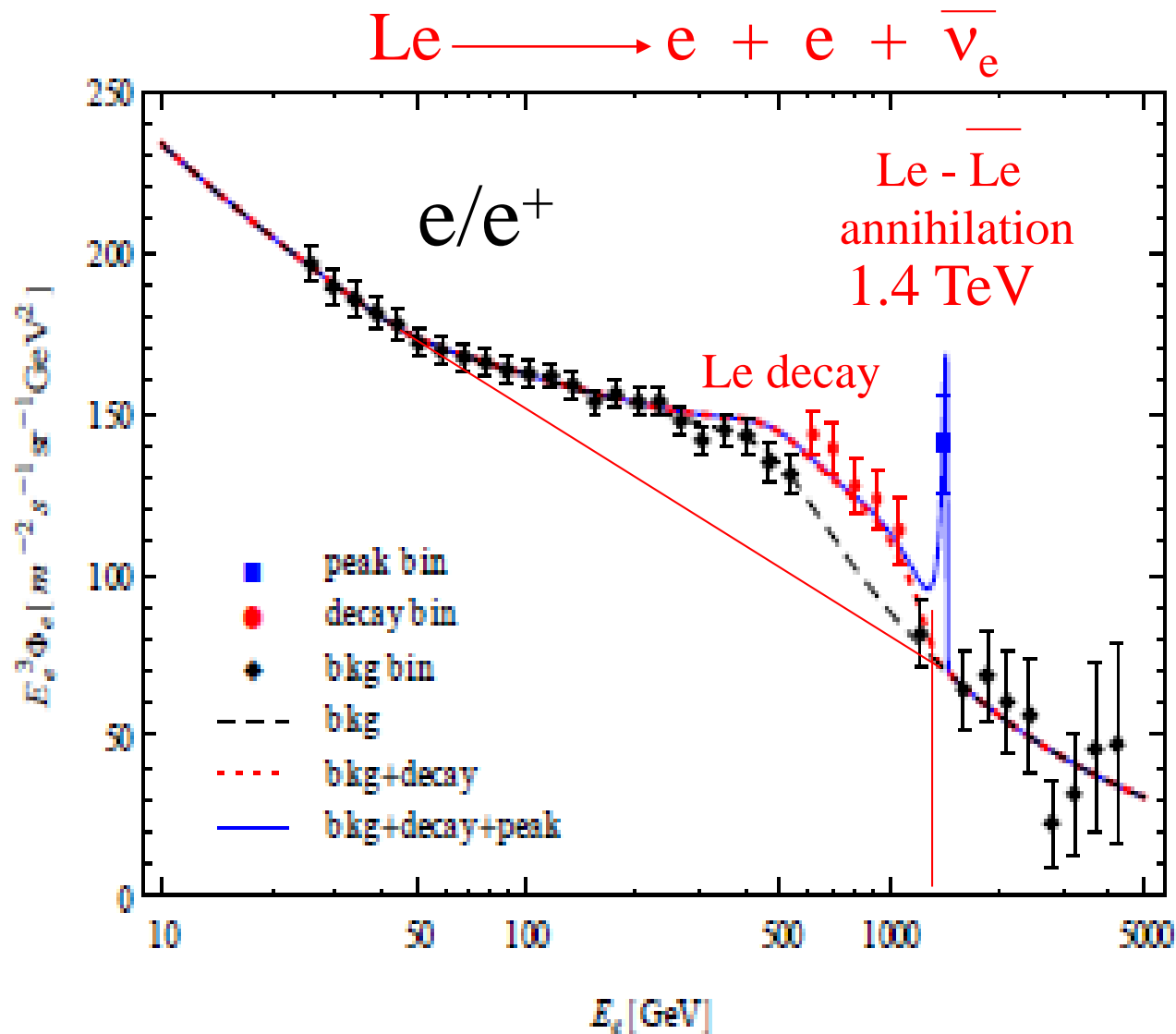
based on $m(L_e) = 1.4 \text{ TeV}/c^2$.

$E = mc^2$; 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.

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

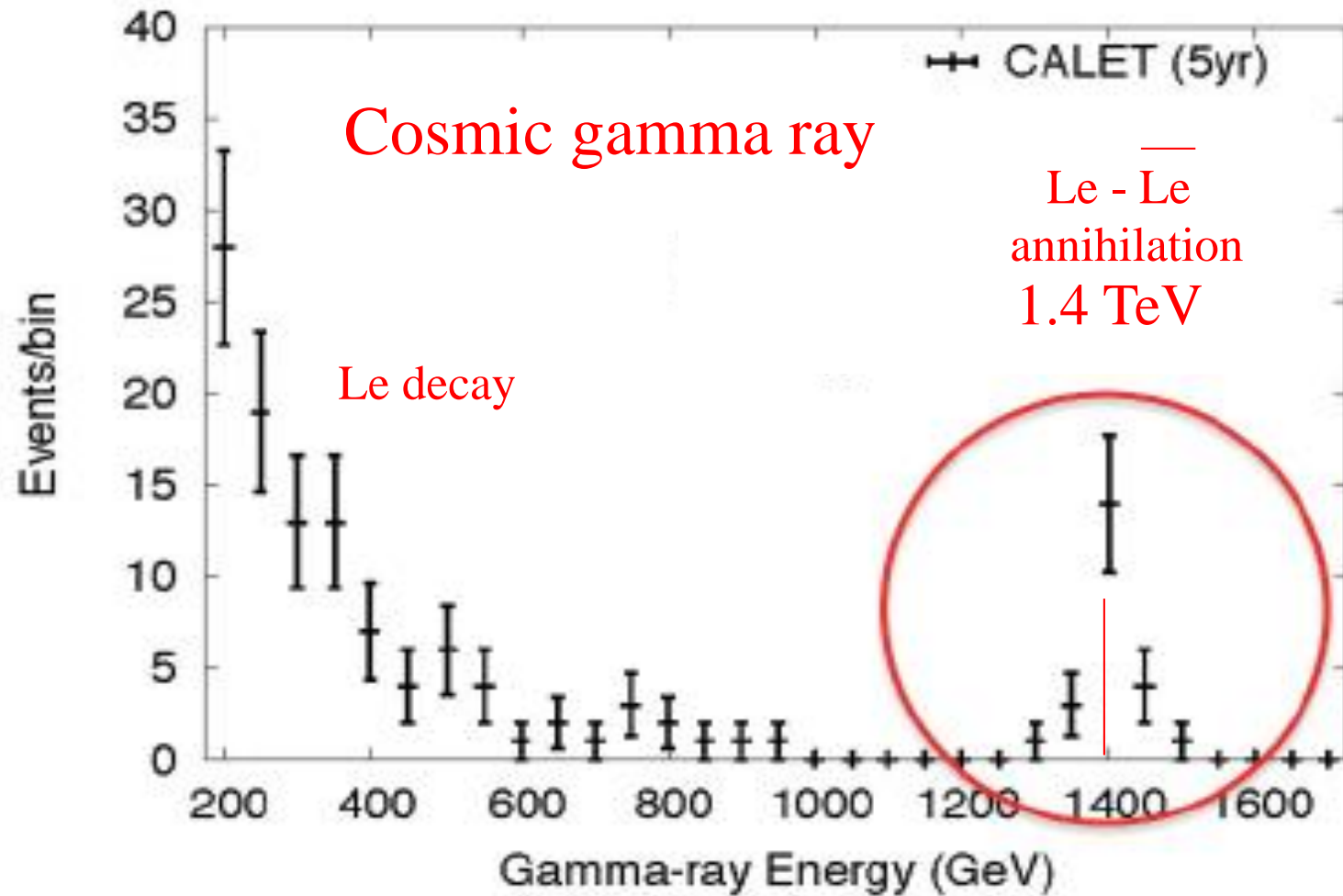
The rest mass energies of the leptons and bastons (dark matters) are calculated and compared with the experimental values.



A rest mass of Le
could be 1.4 TeV/c².

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

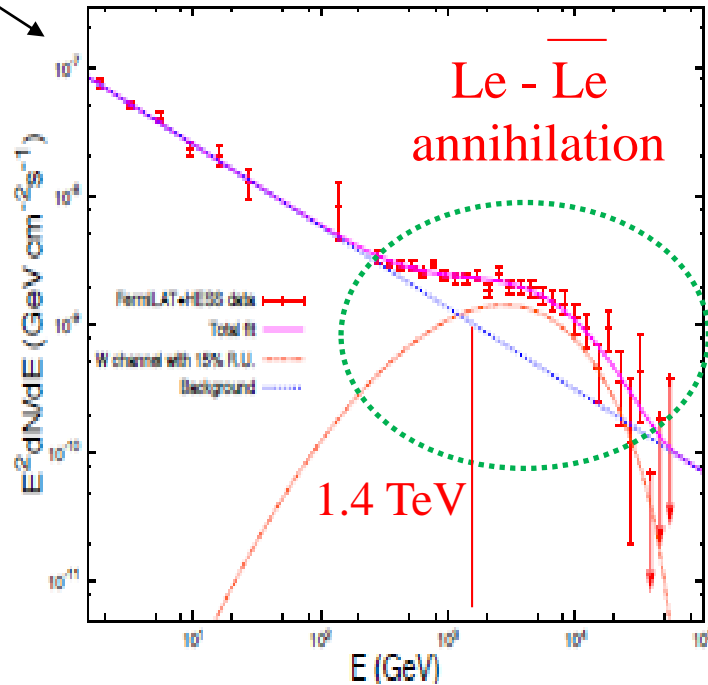
These data support the existence of heavy leptons like Le, L_μ and L_τ.



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 L_e , L_μ and L_τ .

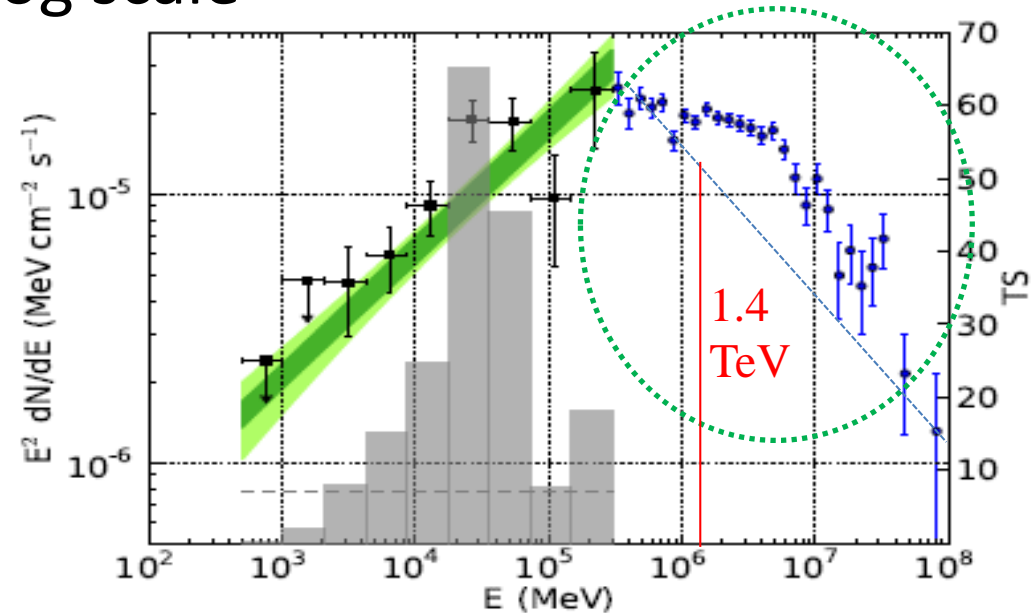
log scale

Le – anti Le annihilation peak.



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

log scale

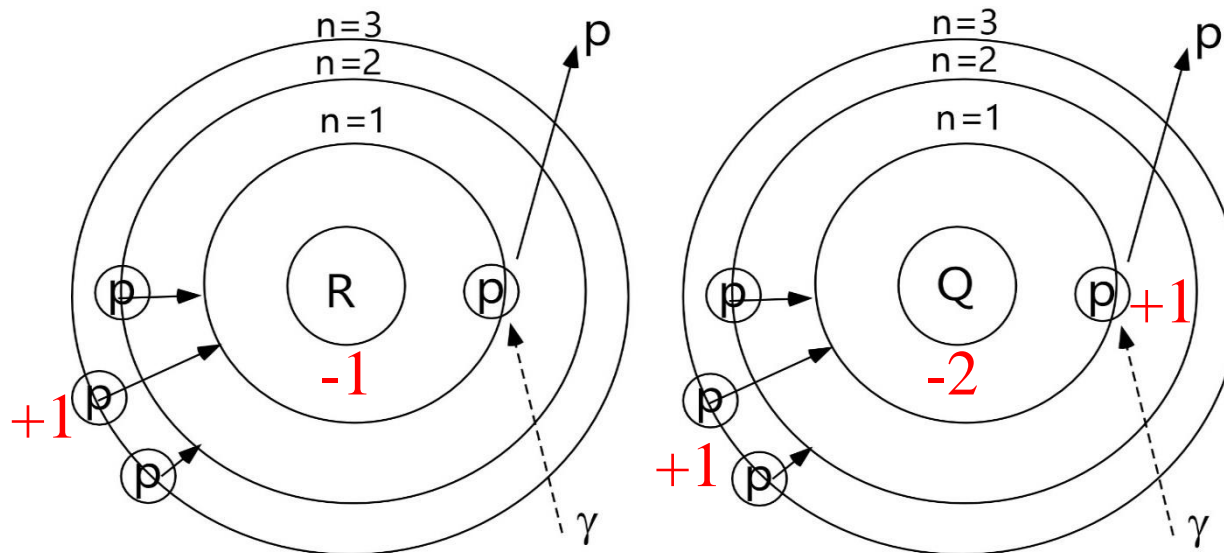


S. Federicici et al., arXiv: 1502.06355v1 (2015).
Analysis of GeV-band gamma-ray emission
from SNR RX J1713.7-3946 with HESS and
Fermi-LAT data.

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

These data support the existence of heavy leptons like Le, L_μ and L_τ .

Heavy Q1 baryon atoms



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

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

$$E_1(x) = E_2 - E_1$$

$$= 18.7 \text{ keV}$$

$$E_2(x) = E_3 - E_2$$

$$= 3.5 \text{ keV}$$

$$E_3(x) = E_3 - E_1$$

$$= 22.2 \text{ keV}$$

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

$$E_1(x) = E_2 - E_1$$

$$= 74.9 \text{ keV}$$

$$E_2(x) = E_3 - E_2$$

$$= 13.9 \text{ keV}$$

$$E_3(x) = E_3 - E_1$$

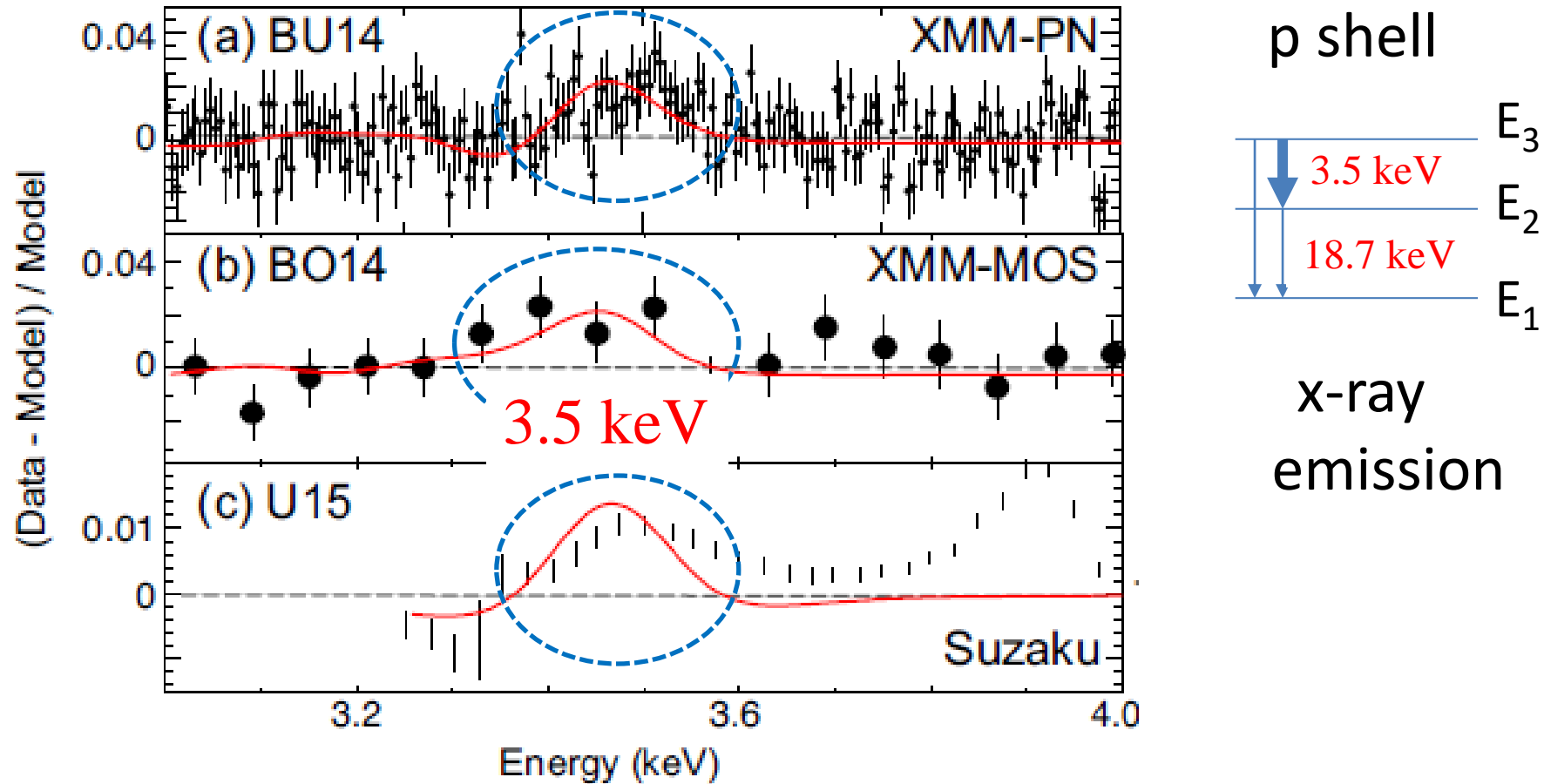
$$= 88.8 \text{ keV}$$

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.

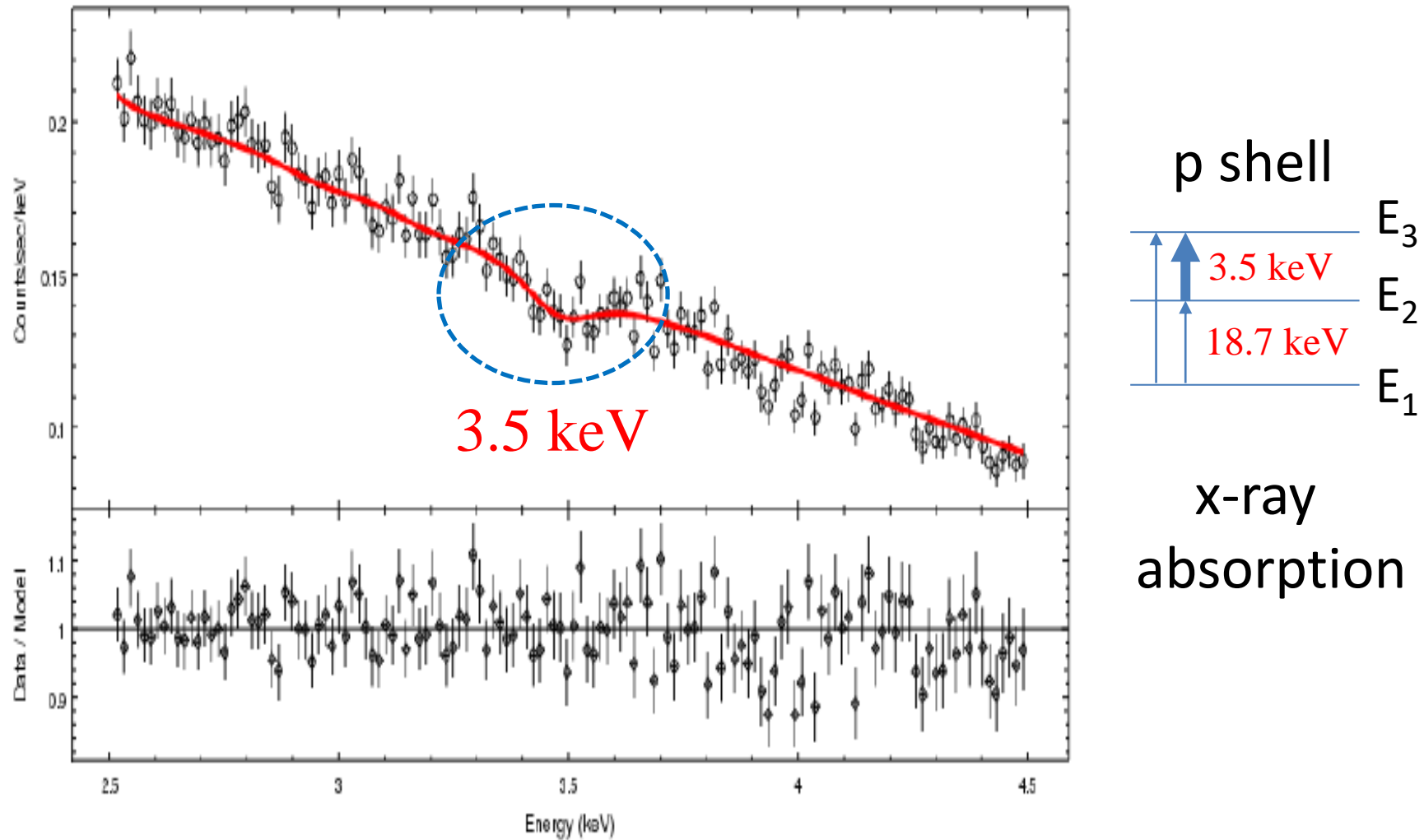
diffuse cluster x-ray emission



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).

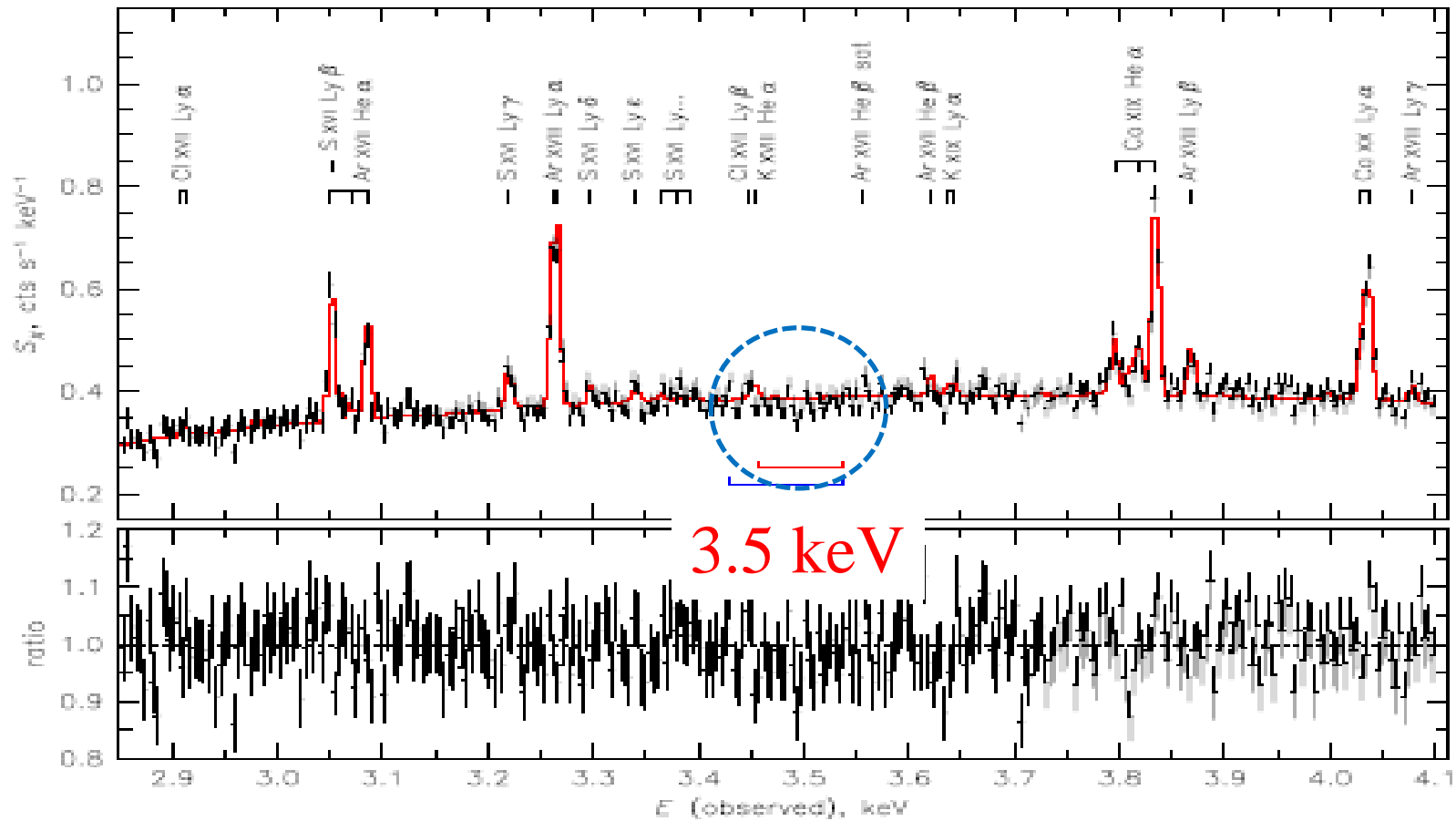
3.5 keV diffuse x-ray emission line from nearby galaxies and galaxy clusters



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



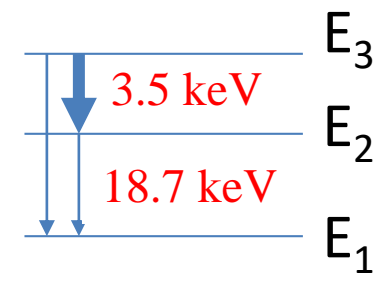
3.5 keV AGN x-ray spectrum with Hitomi for Perseus cluster

F.A. Aharonian et 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?

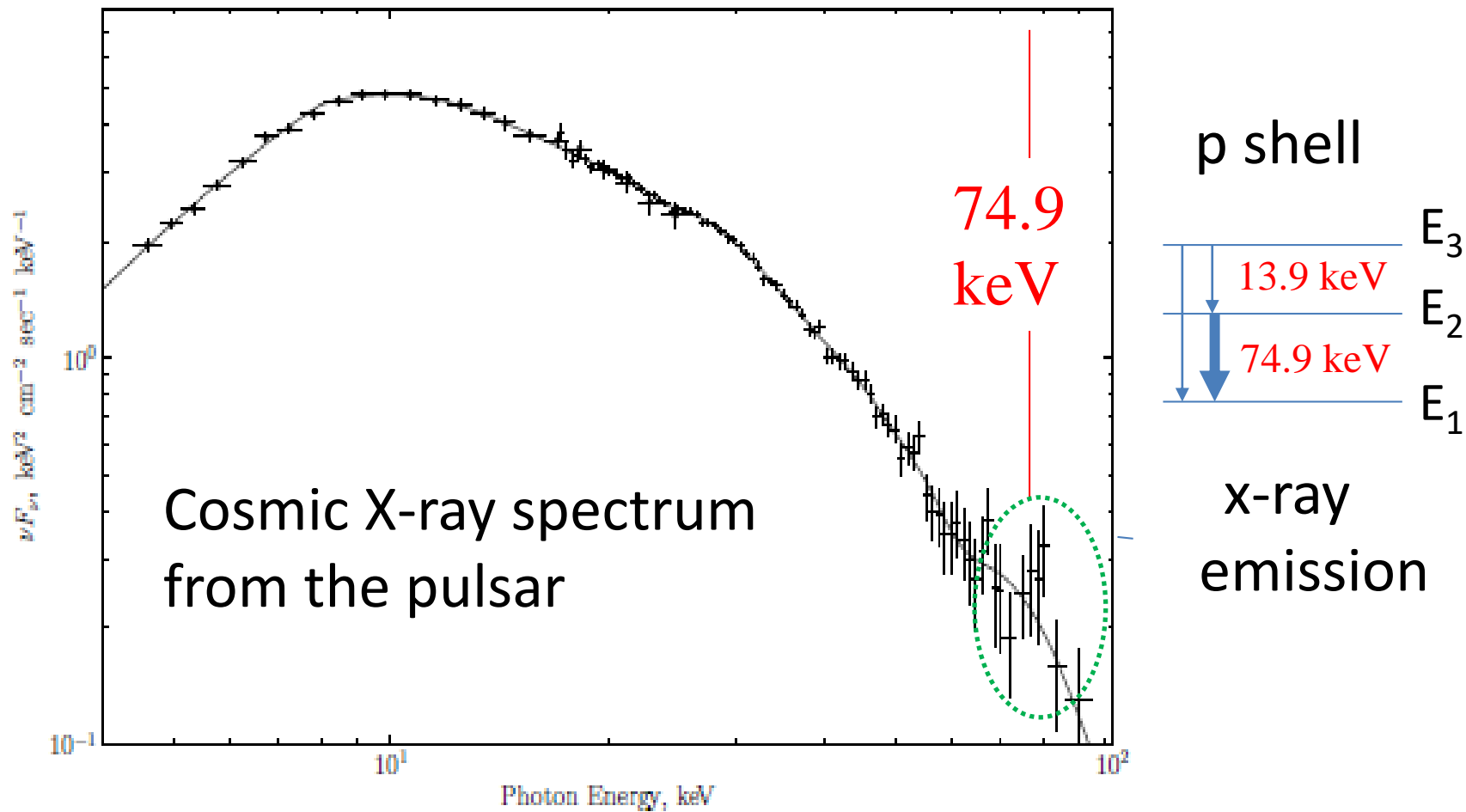
p shell



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)

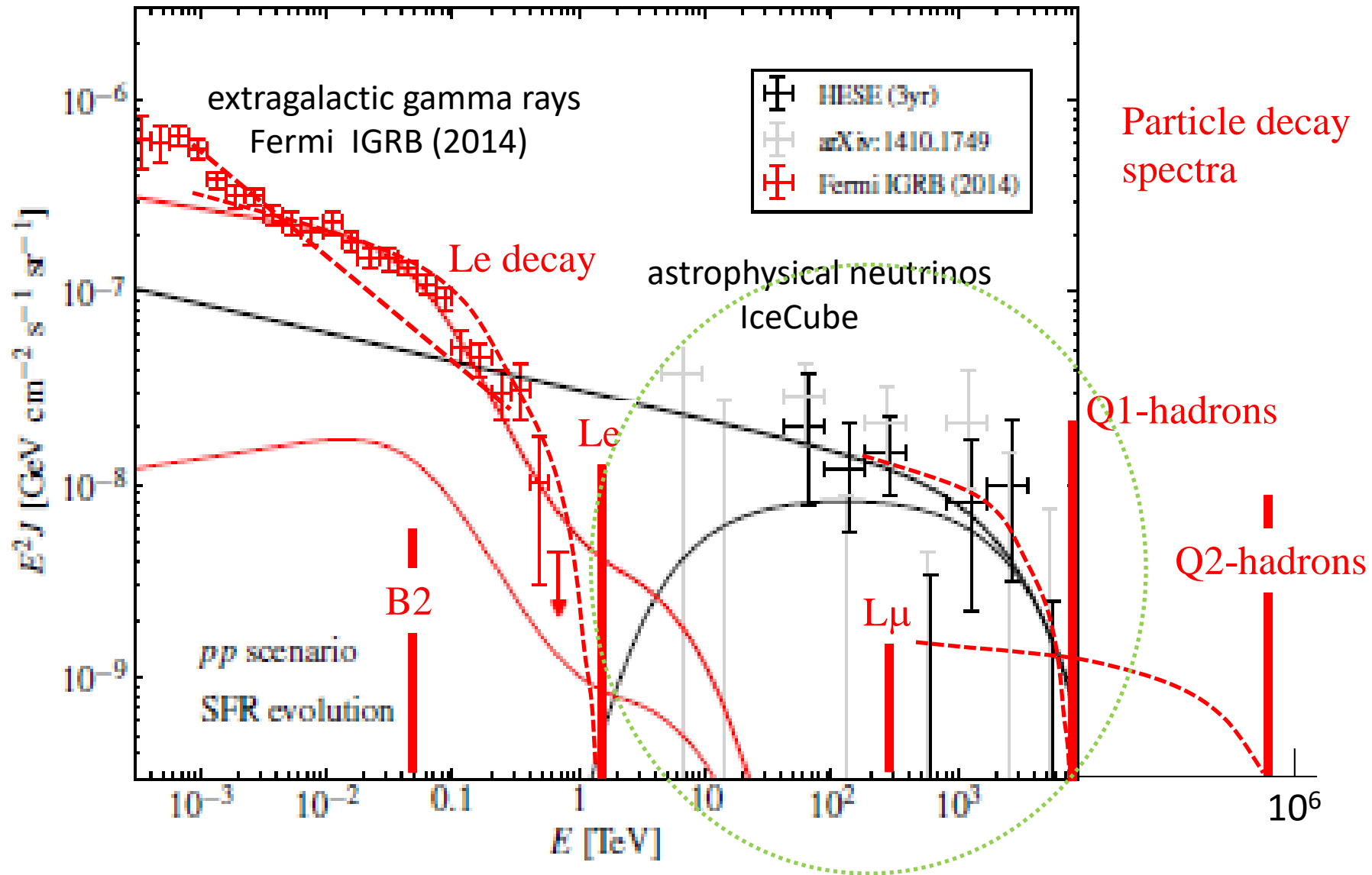


Broadband energy spectrum of the X-ray pulsar 4U 0115+63 from IBIS/ISGRI and JEM-X(INTEGRAL) data in its bright state during the out burst in May-June 2011.

P.A. Boldin et al., Astronomy Letters 39, 375 (2013).

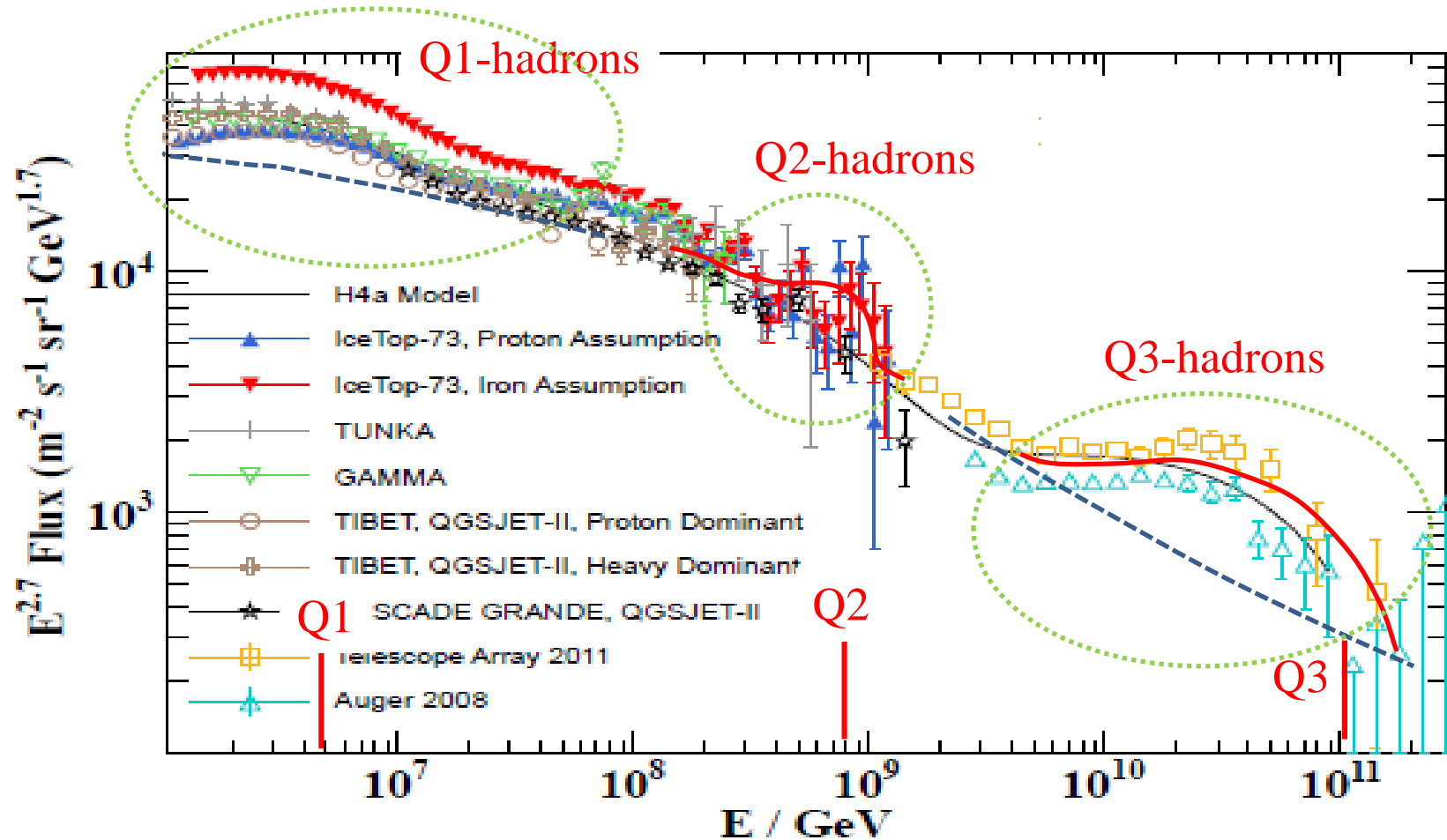
Possible discoveries of 3.5 keV and 74.9 keV x ray peaks support the existence of the new heavy Q1 quark with $EC = -4/3$. This can justify the Q1, Q2 and Q3 quarks.

Ultra high energy neutrino measurements



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

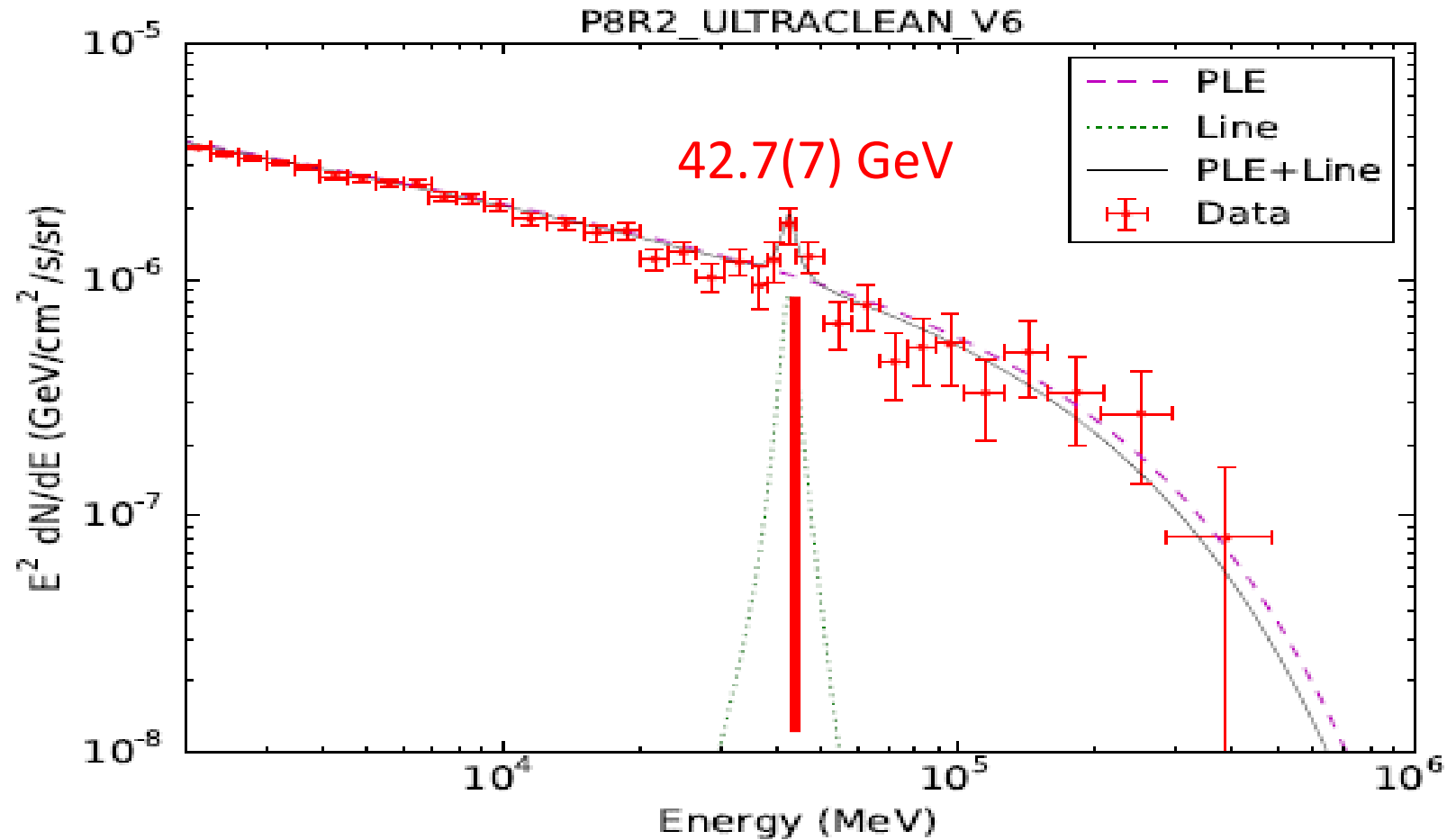
IceCube-Gen2: A Vision for the Future of Neutrino Astronomy in Antarctica



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

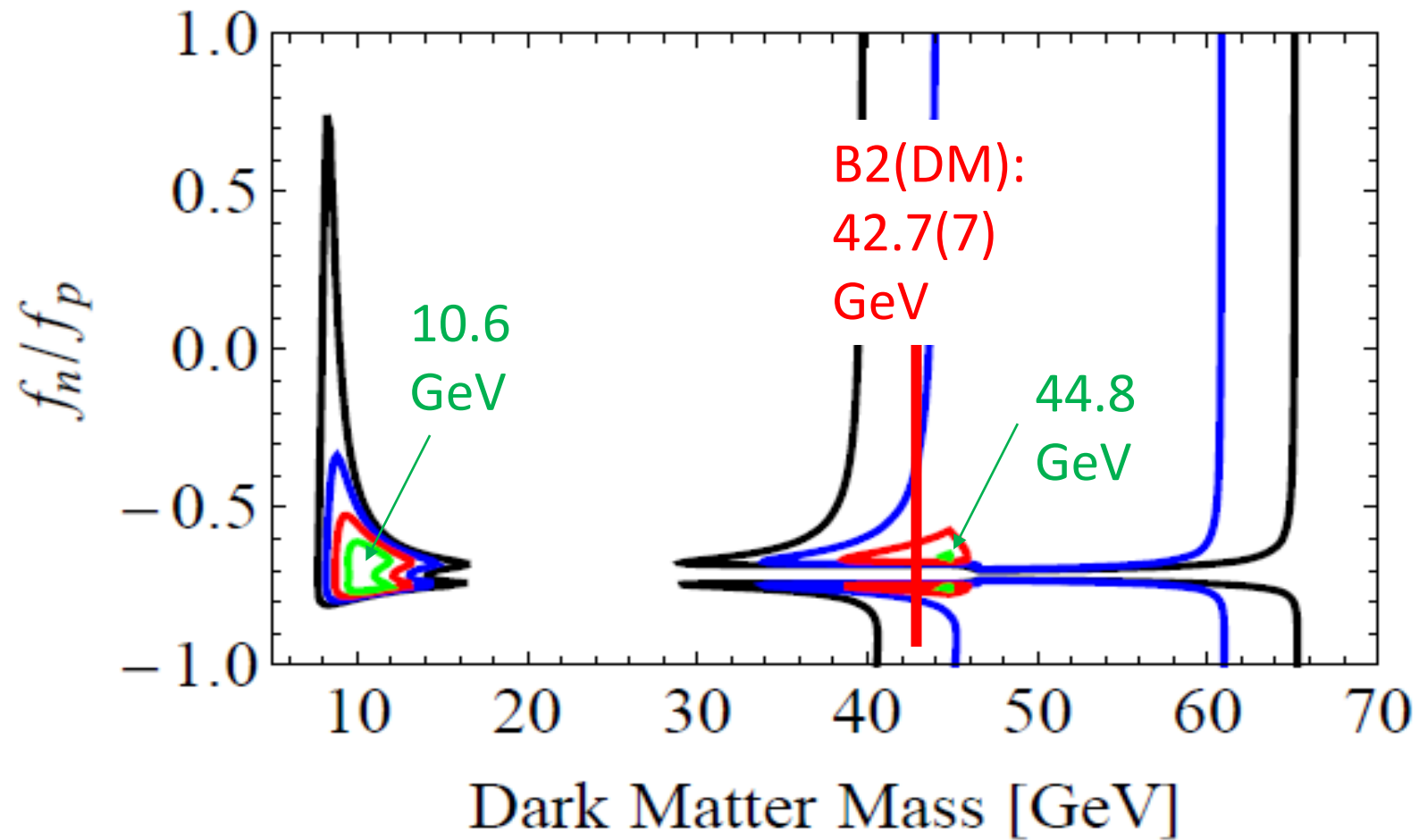
B2 fermionic dark matter measurements



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.

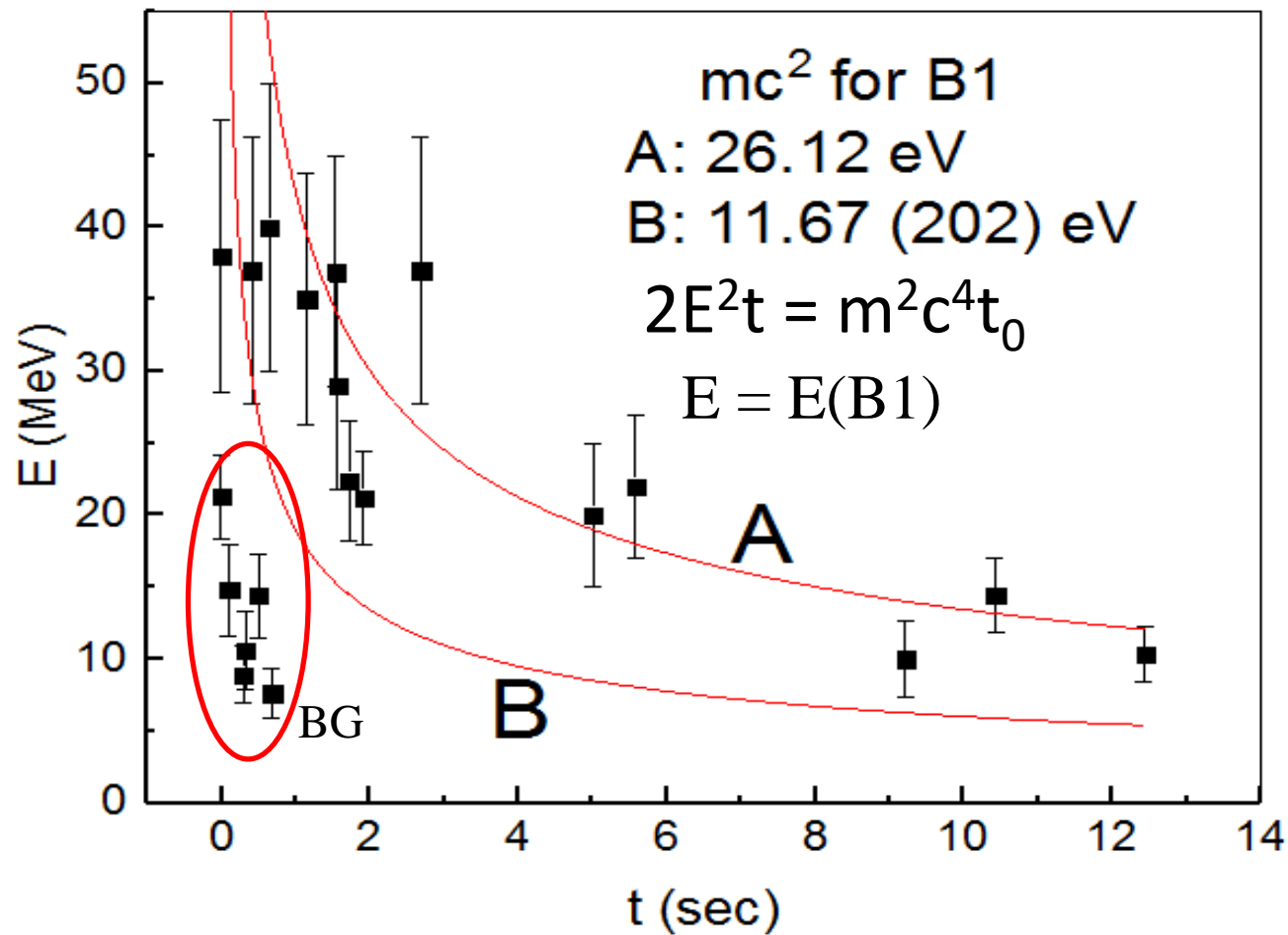
Y.F. Liang et al., Phys. Rev. D 93, 103525 (2016).

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 et al., ArXiv:1804.01231v1 (2018)



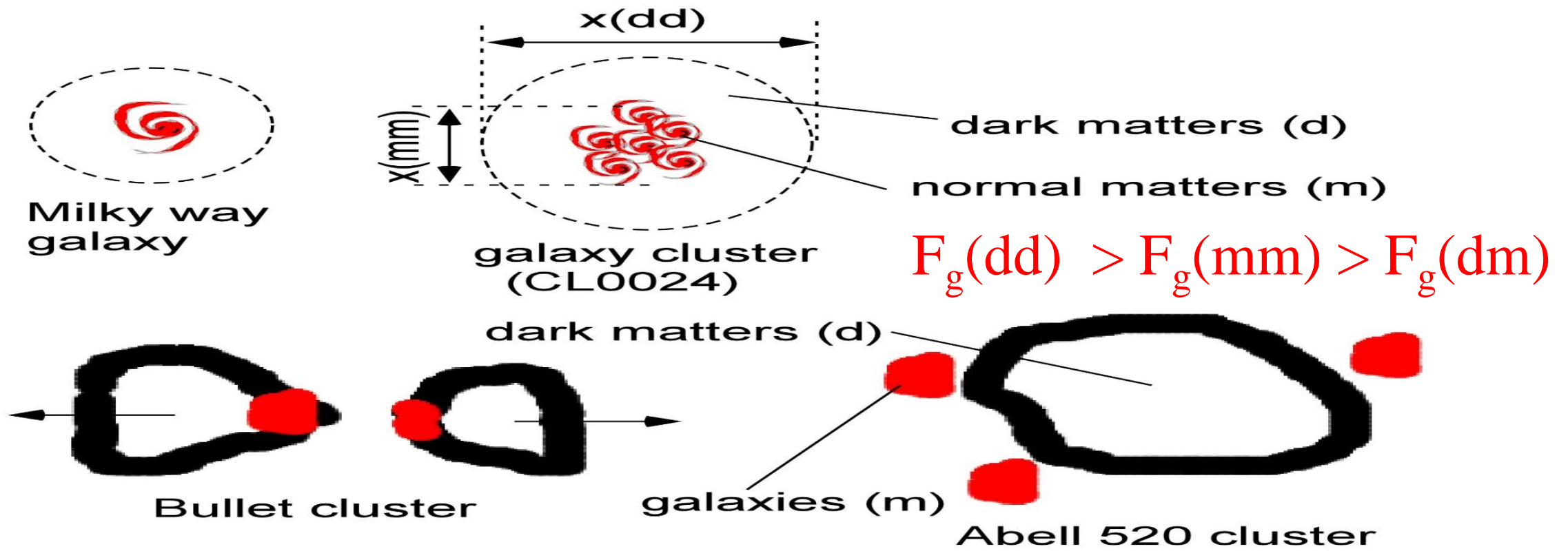
Elastic scattering
 $\nu + e^- \rightarrow \nu + e^-$
 $B1 + e^- \rightarrow B1 + e^-$

Anti neutrino data \rightarrow B1
 dark matter data
 Kamiokande-II + IMB

BG: background counts
 (6 data)

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

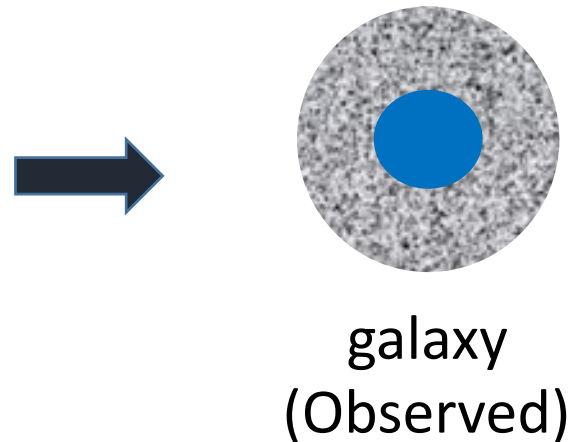
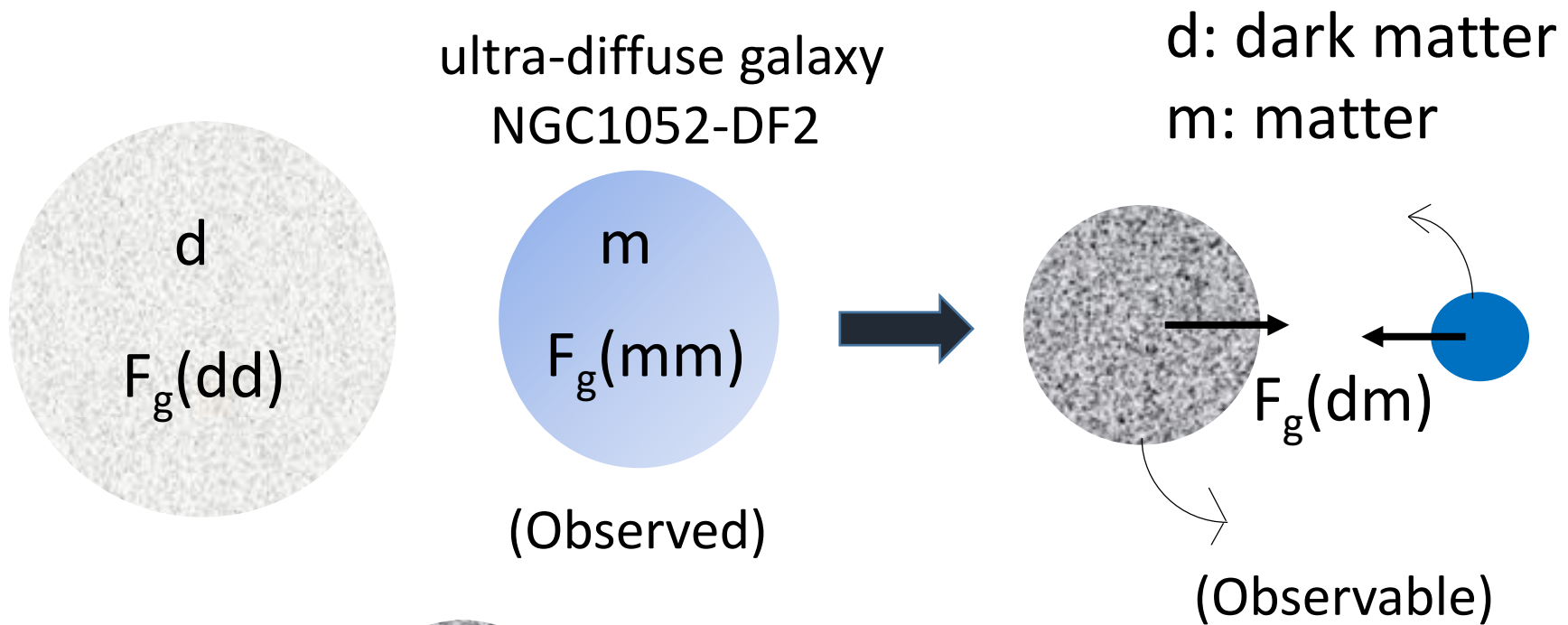
The curve A fits the observed data well except the 6 BG data. The curve A uses the proposed dark matter mass of B1. It is proposed that **the B1 particles come from SN 1987A to the earth.** The energies, $E(\nu)$ of the observed neutrinos are reinterpreted as the energies, $E(B1)$ of the B1 dark matters. **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.



For elementary particles with the same conditions;
 F_g : gravitational force strength
 F_c : electromagnetic force strength
 $F_c(mm) > F_g(dd) > F_c(dd) > F_g(mm) > F_g(dm) > F_c(dm) = 0$

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
 $x(dd) = 3x(mm) > x(mm)$



$$F_g(dd) > F_g(mm) > F_g(dm)$$

Gravitational force range
 $x(dd) > x(mm)$

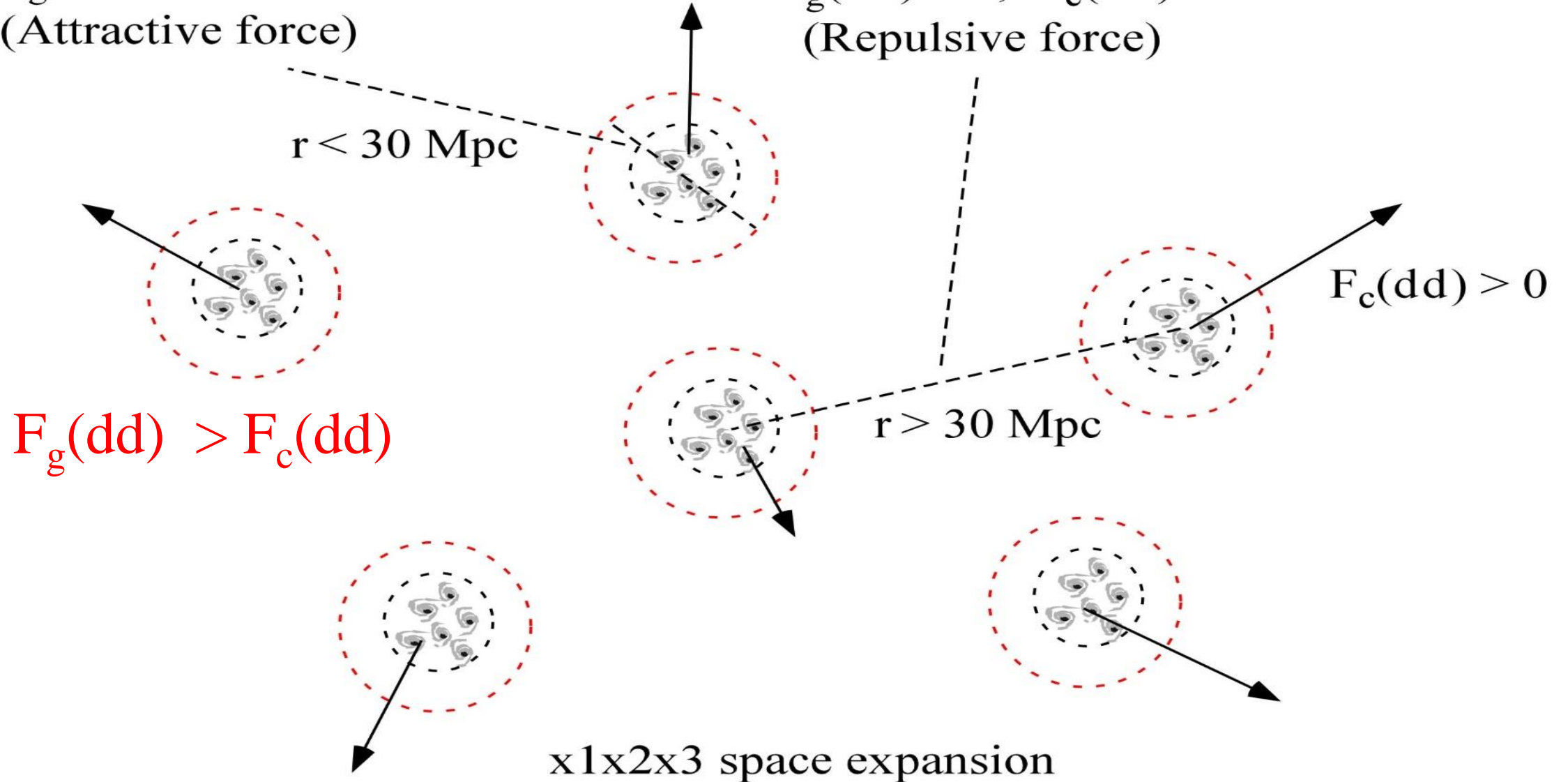
NGC1052-DF2: A galaxy lacking dark matter
P. Van Dokkum et al., Nature **555**, 629 (2018).

Within dark matter galaxy cluster,
 $r < 30$ Mpc

$F_g(dd) - F_c(dd) > 0$
(Attractive force)

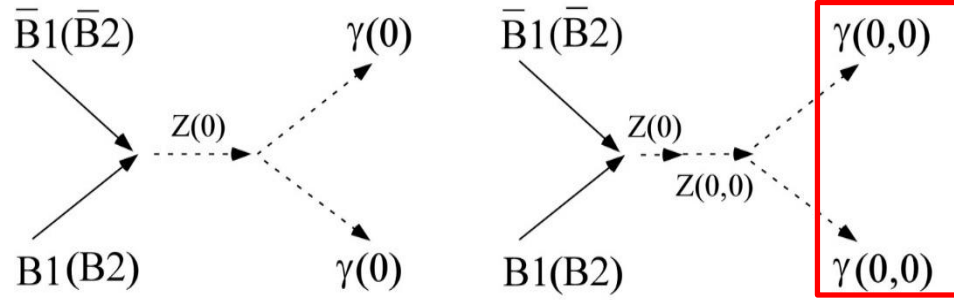
Between dark matter galaxy clusters,
 $r > 30$ Mpc

$F_g(dd) = 0, F_c(dd) > 0$
(Repulsive force)



particle - anti particle annihilations

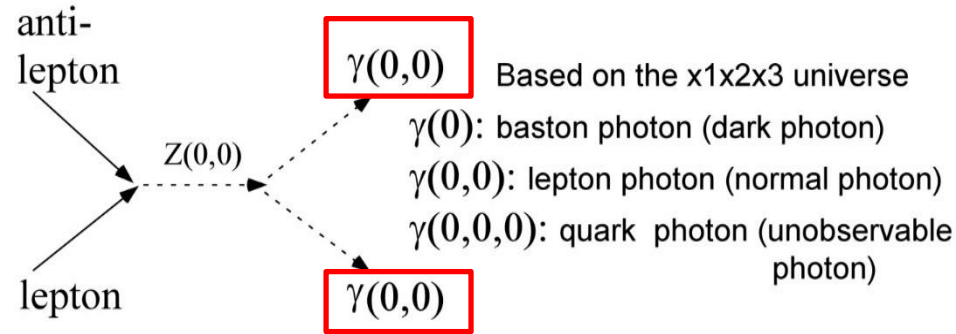
$I(\gamma(0)) \gg I(\gamma(0,0))$
(Dark matters)



Observable
(weak)

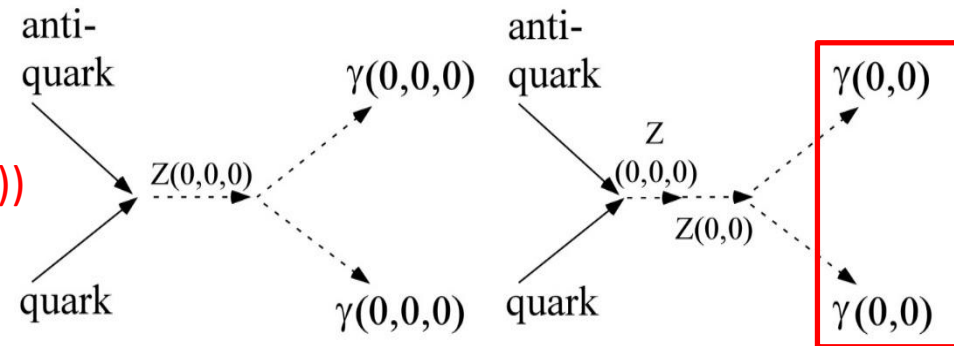
Difficult but
possible to be
observed at LHC

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



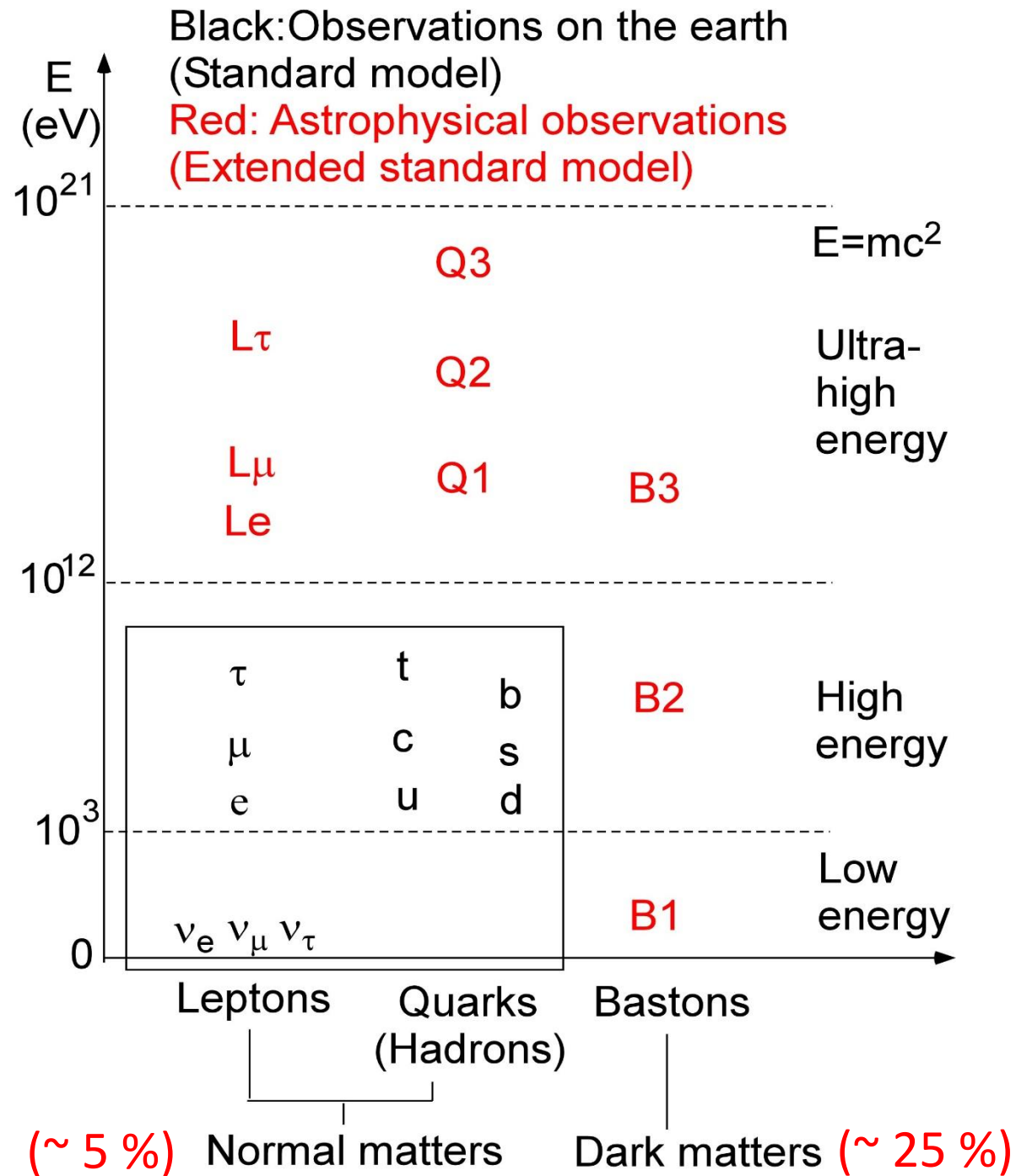
$\gamma(0,0)$:
Observable
(strong)

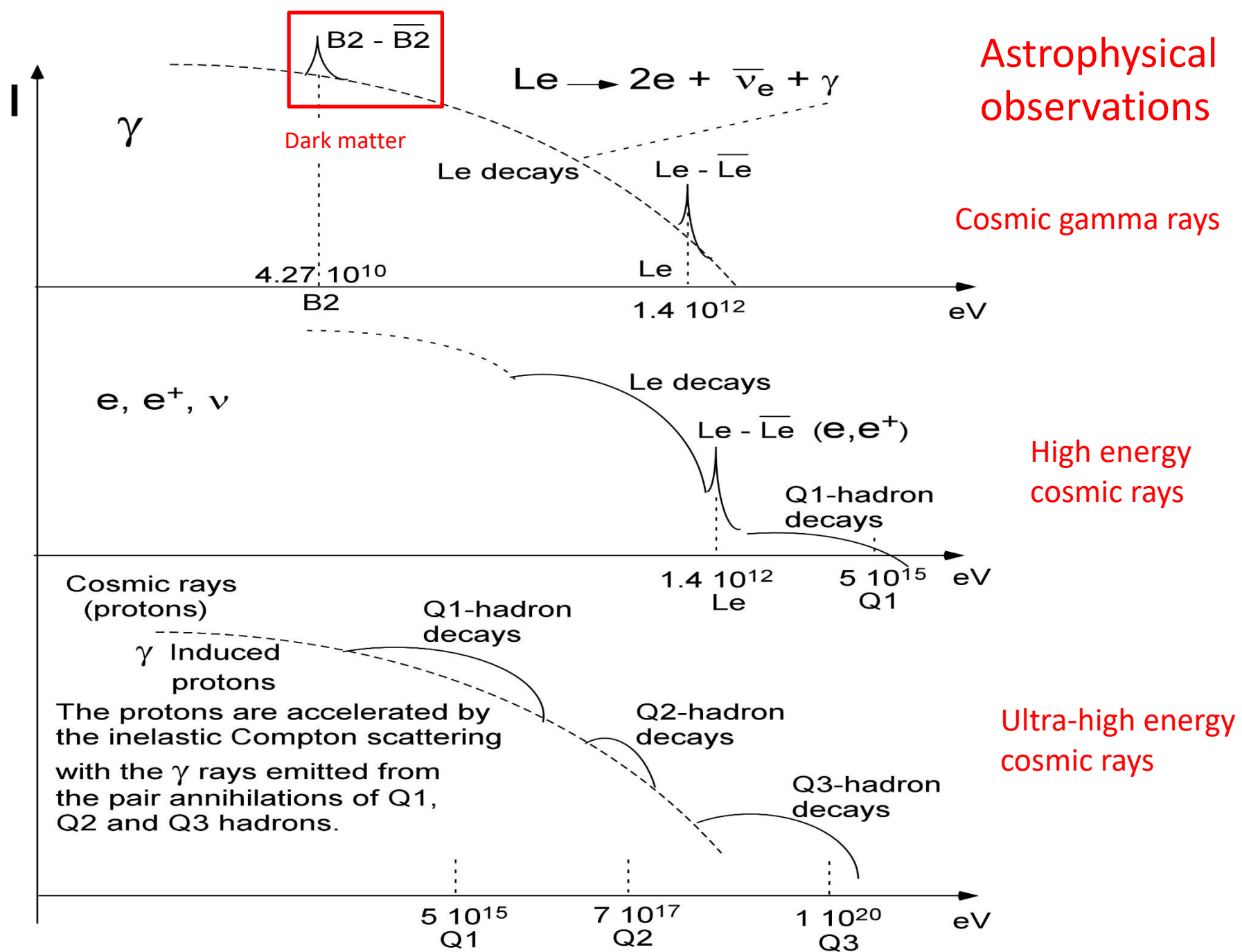
$I(\gamma(0,0,0)) \gg I(\gamma(0,0))$
(Quarks)

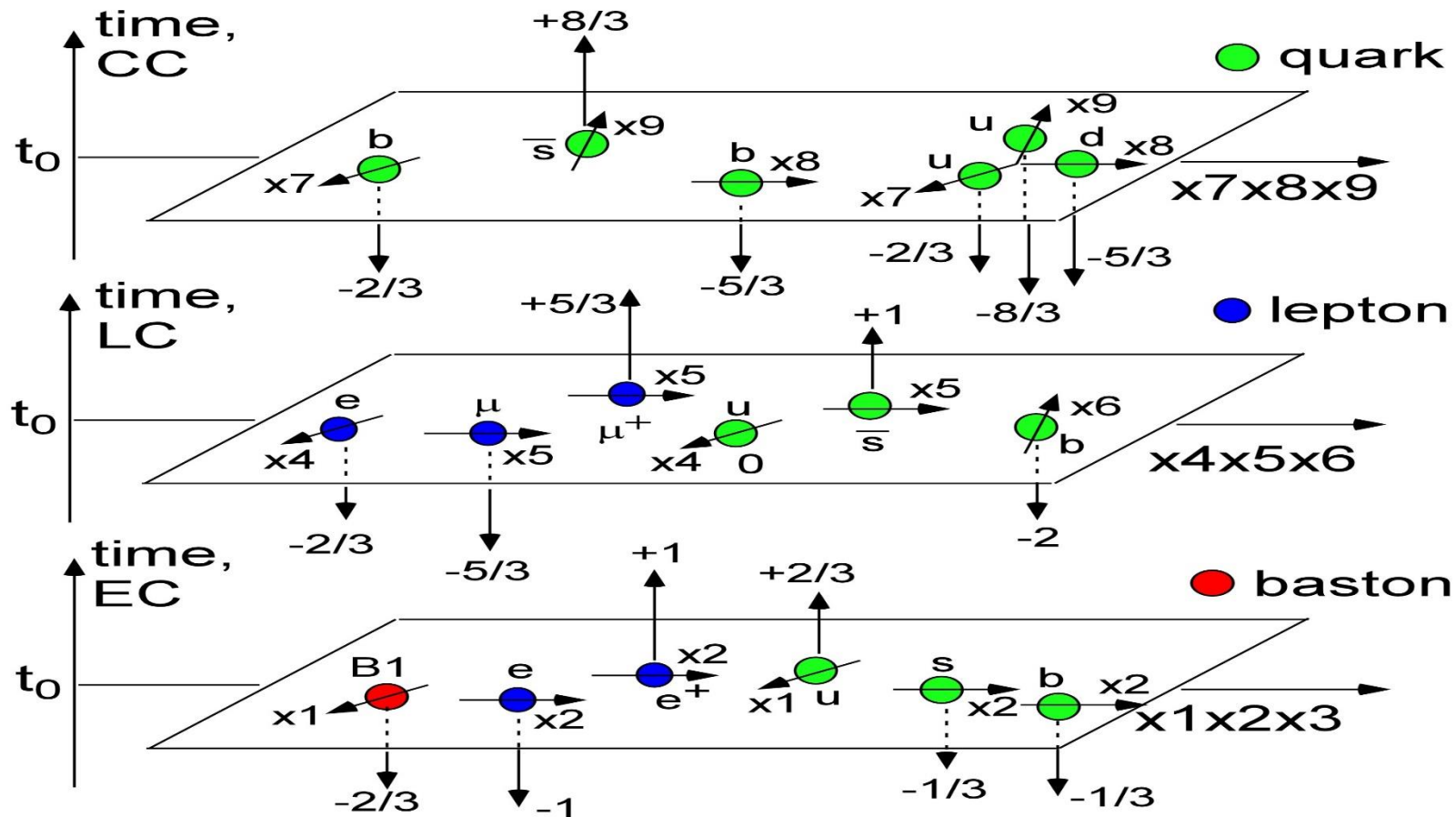


Observable
(weak)

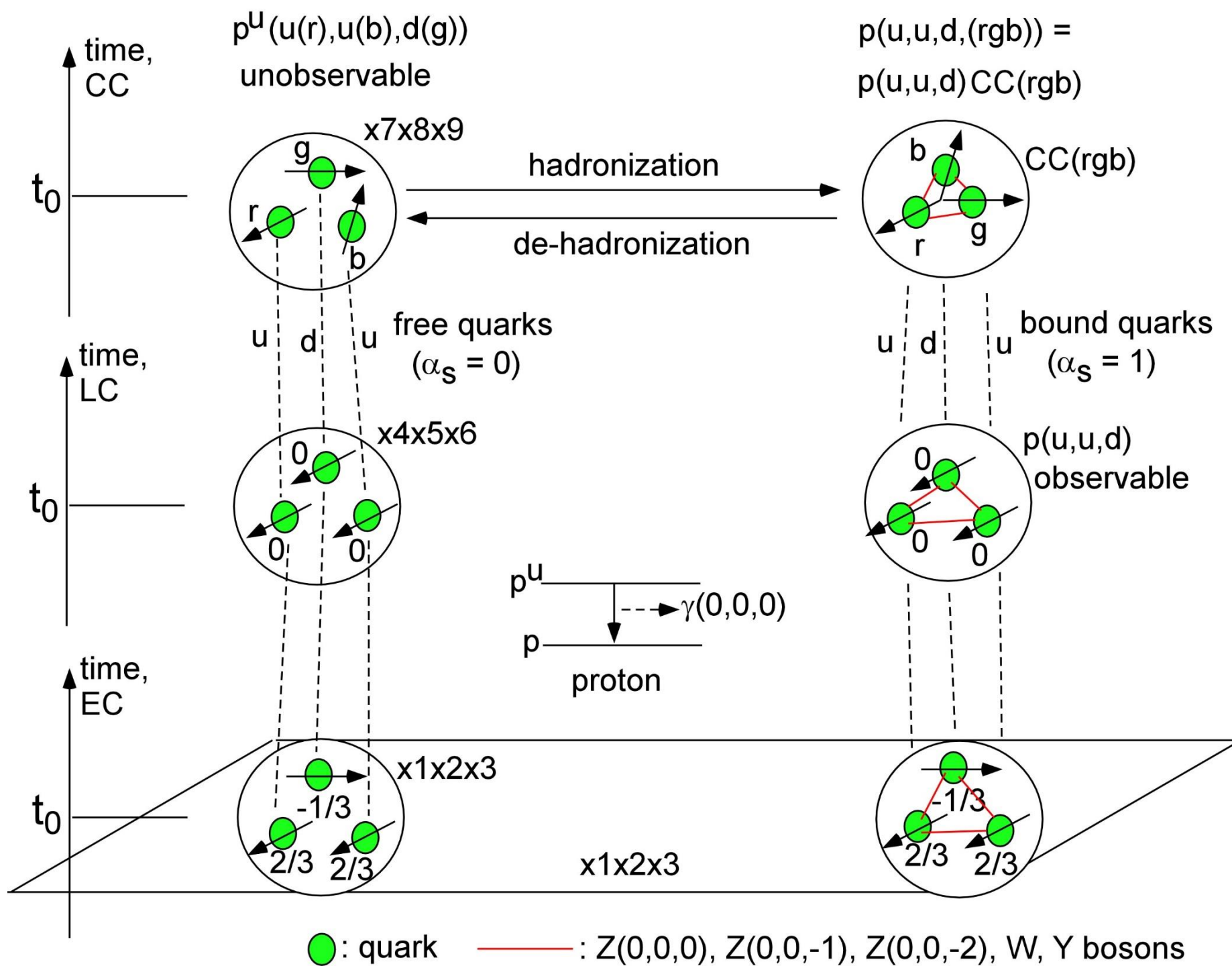
$Z(0) \longleftrightarrow Z(0,0) \longleftrightarrow Z(0,0,0)$: Force carrying bosons
 $\gamma(0) \not\longleftrightarrow \gamma(0,0) \not\longleftrightarrow \gamma(0,0,0)$: Charge dependent photons
 $g(0) \longleftrightarrow g(0,0) \longleftrightarrow g(0,0,0)$: gravitons



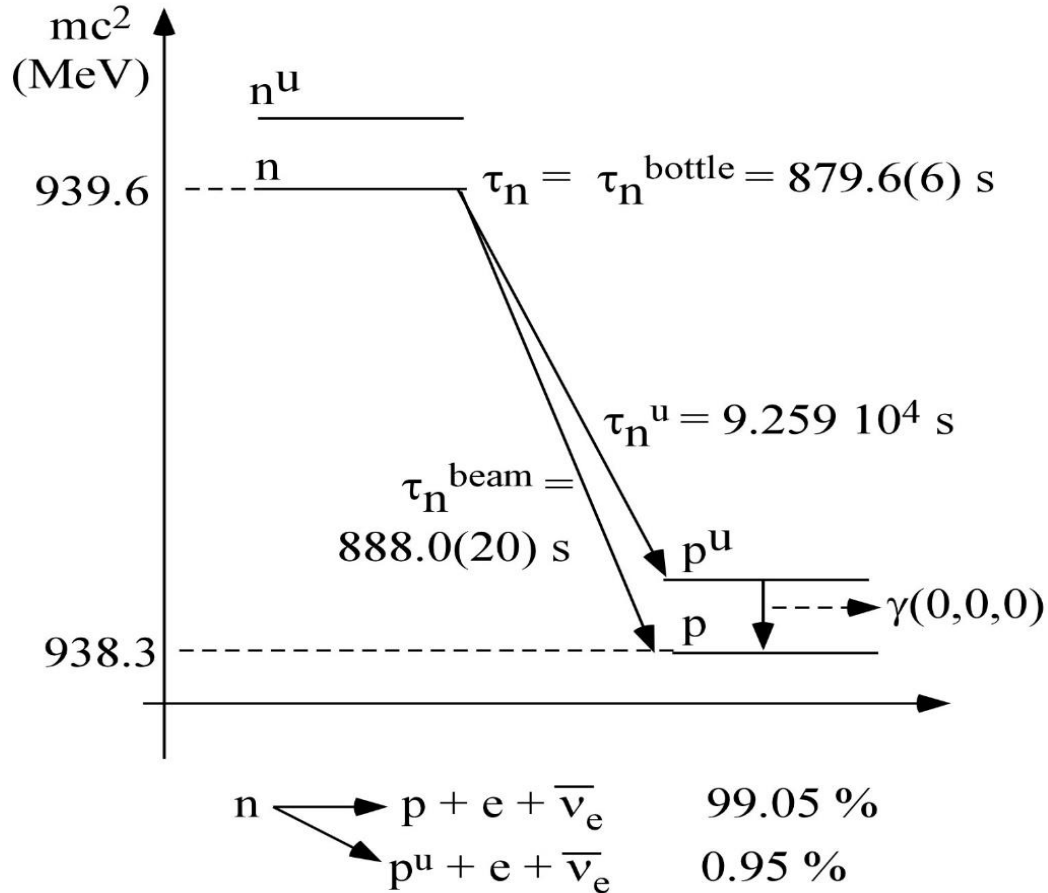




Negative and positive charges along the negative time axis and positive time axis, respectively, can be added and subtracted like the scalars on the three-dimensional quantized spaces. The EC, LC and CC charges are different from the vectors like the angular momenta on the three-dimensional quantized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



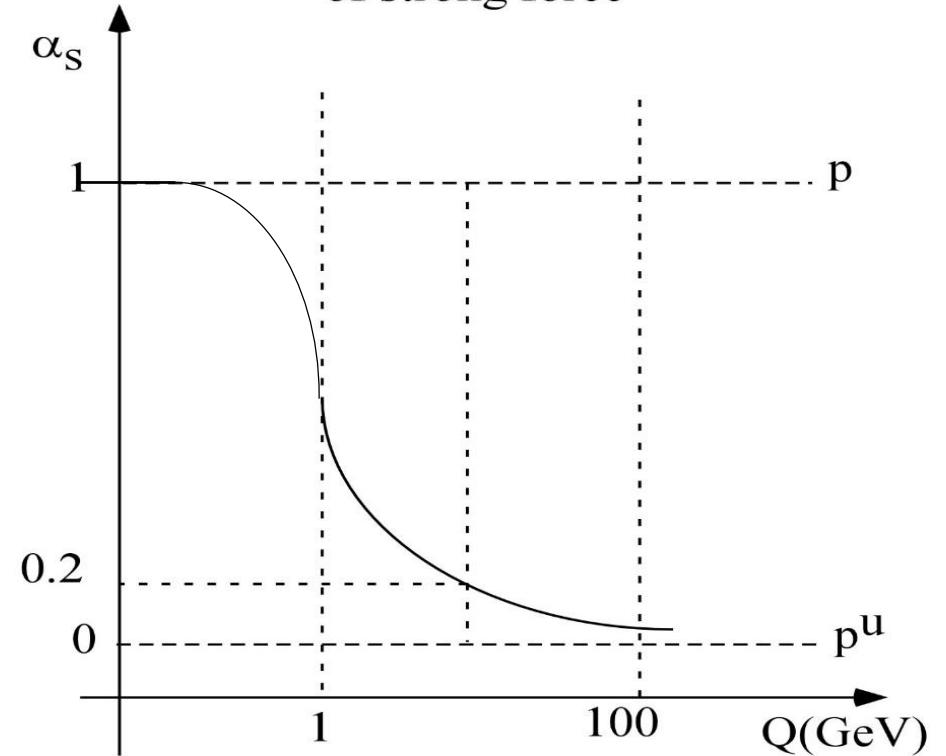
neutron lifetime anomaly



The lifetime of the p^u state is long enough to show the neutron lifetime anomaly.

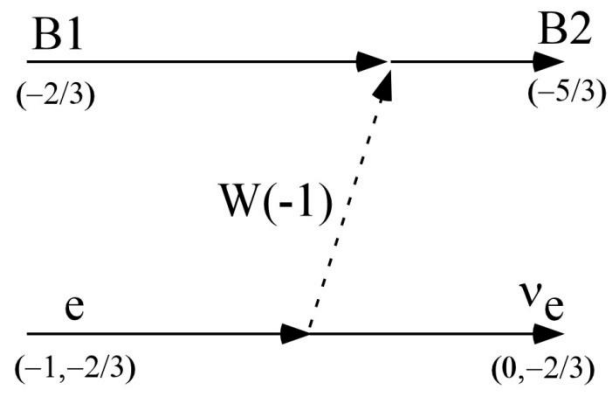
The beta (p^u) ray could be observed by subtracting the beta (p) ray from the total beta ($p+p^u$) ray spectrum.

coupling constant of strong force

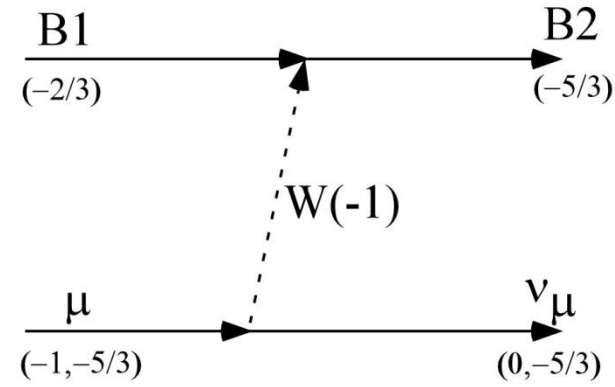
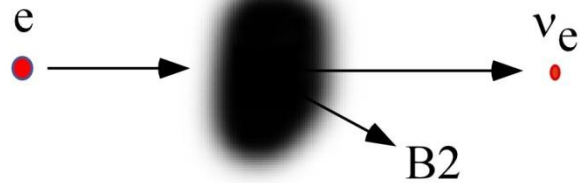


$$\langle \alpha_s \rangle = \frac{N(p)}{N(p) + N(p^u)} = 0.2$$

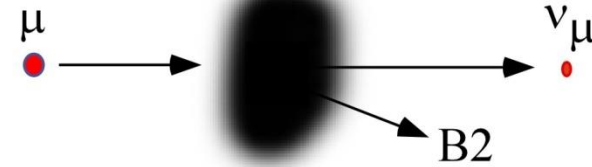
Q : momentum transferred to quarks in deep inelastic scattering experiments



B1
(dark matters)



B1
(dark matters)

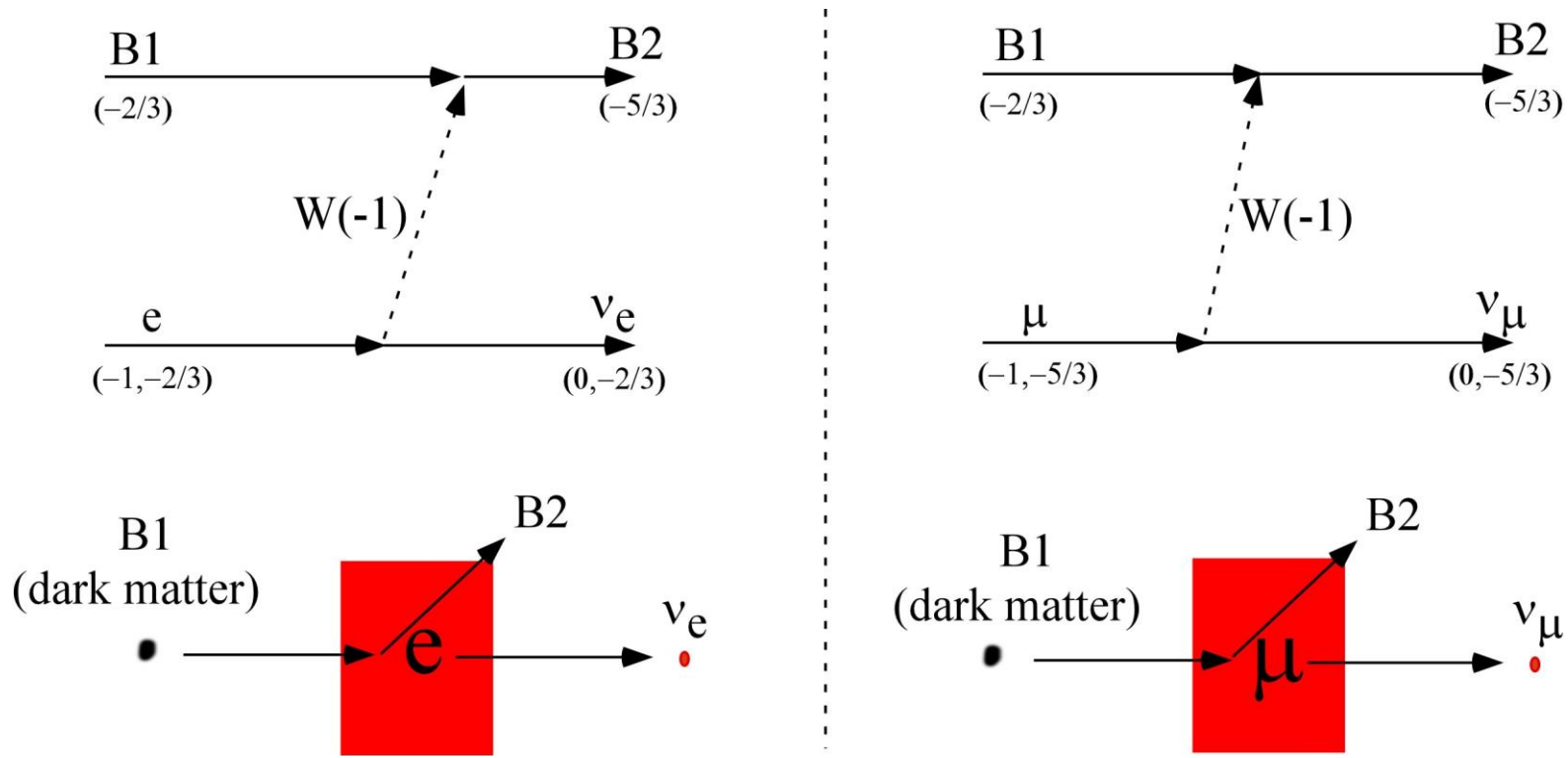


From the B1 - e and B1- μ reactions, the cosmic e and μ particles are transferred to the cosmic ν_e and ν_μ neutrinos, respectively.

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



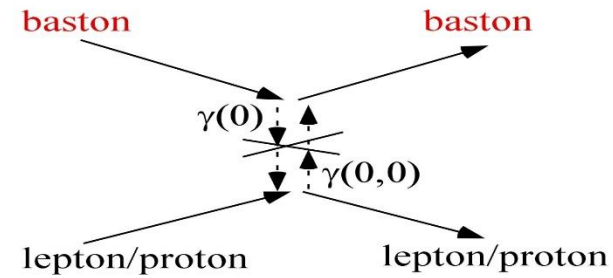
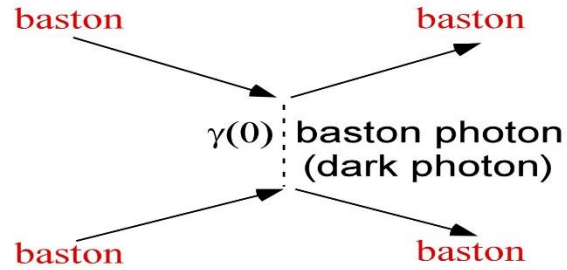
From the B1 $-e$ and B1- μ reactions, the e and μ particles are transferred to the ν_e and ν_μ neutrinos, respectively.

LHC and cosmic neutrino experiments are needed.

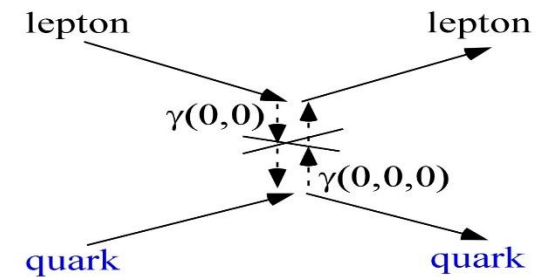
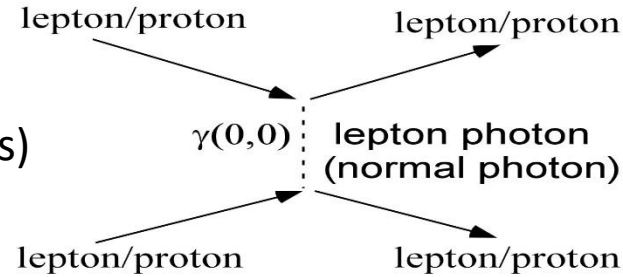
The enhanced neutrino observation is the indirect evidence of the B1 and B2 dark matters produced at LHC.

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

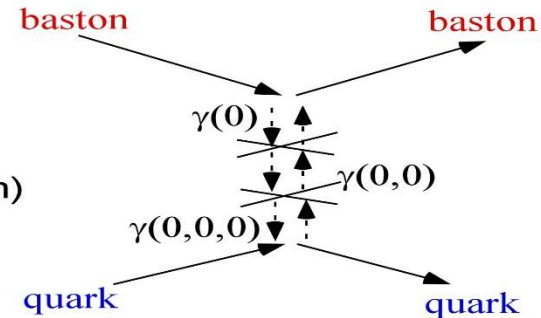
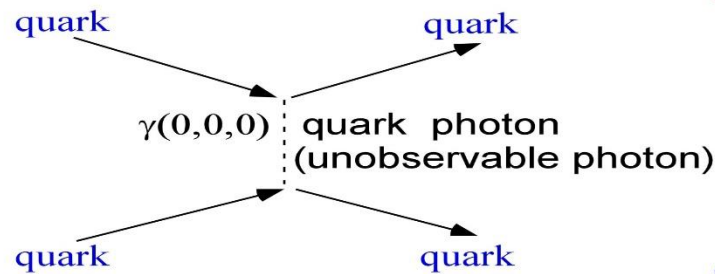
Dark matters
(Bastons)



Normal matters
(Leptons,
Baryons, Mesons)



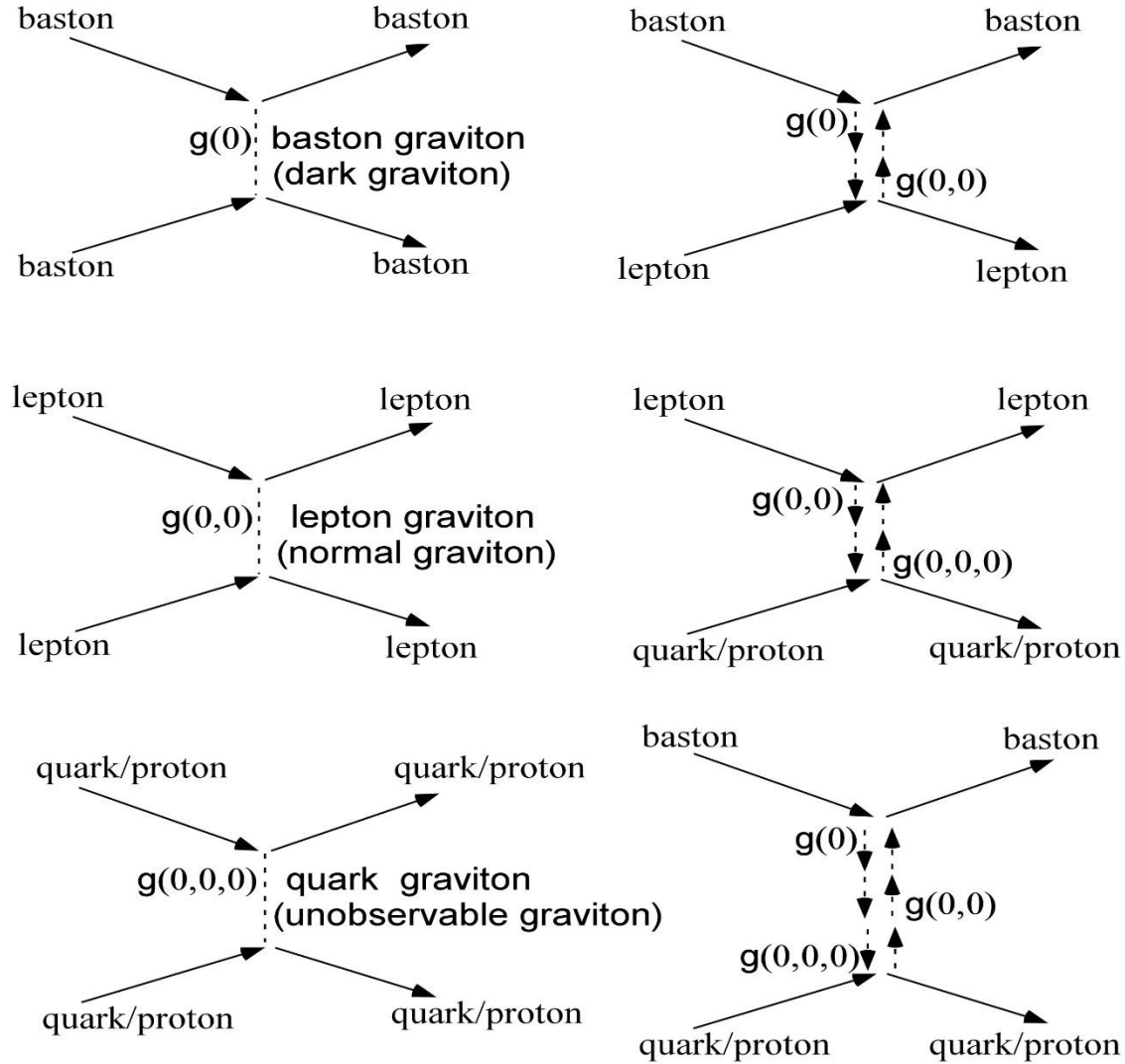
Unobservable
Matters
(Quarks)



$Z(0) \longleftrightarrow Z(0,0) \longleftrightarrow Z(0,0,0)$: Force carrying bosons
 $\gamma(0) \not\leftrightarrow \gamma(0,0) \not\leftrightarrow \gamma(0,0,0)$: 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 $g(0,0,0)$

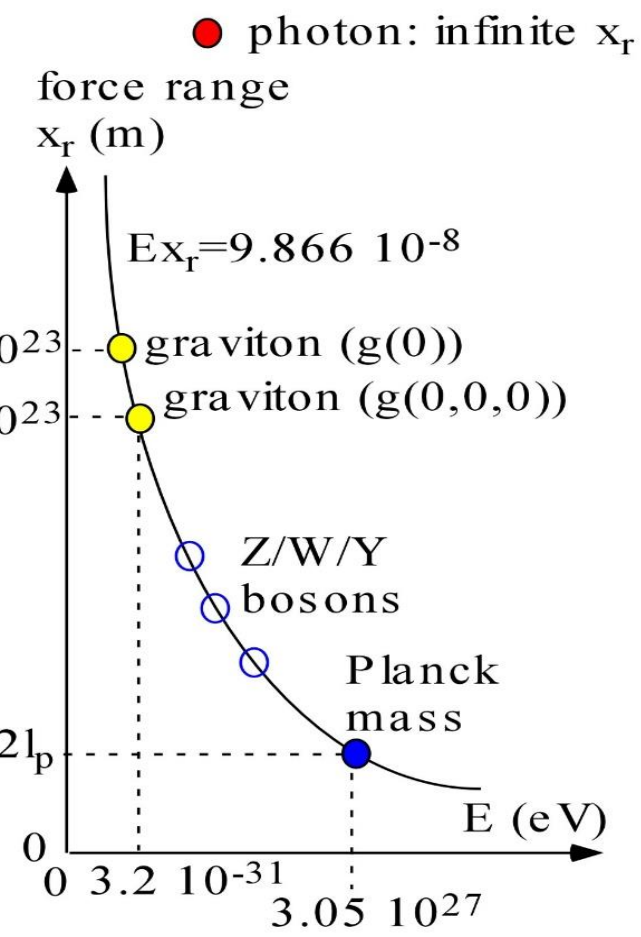
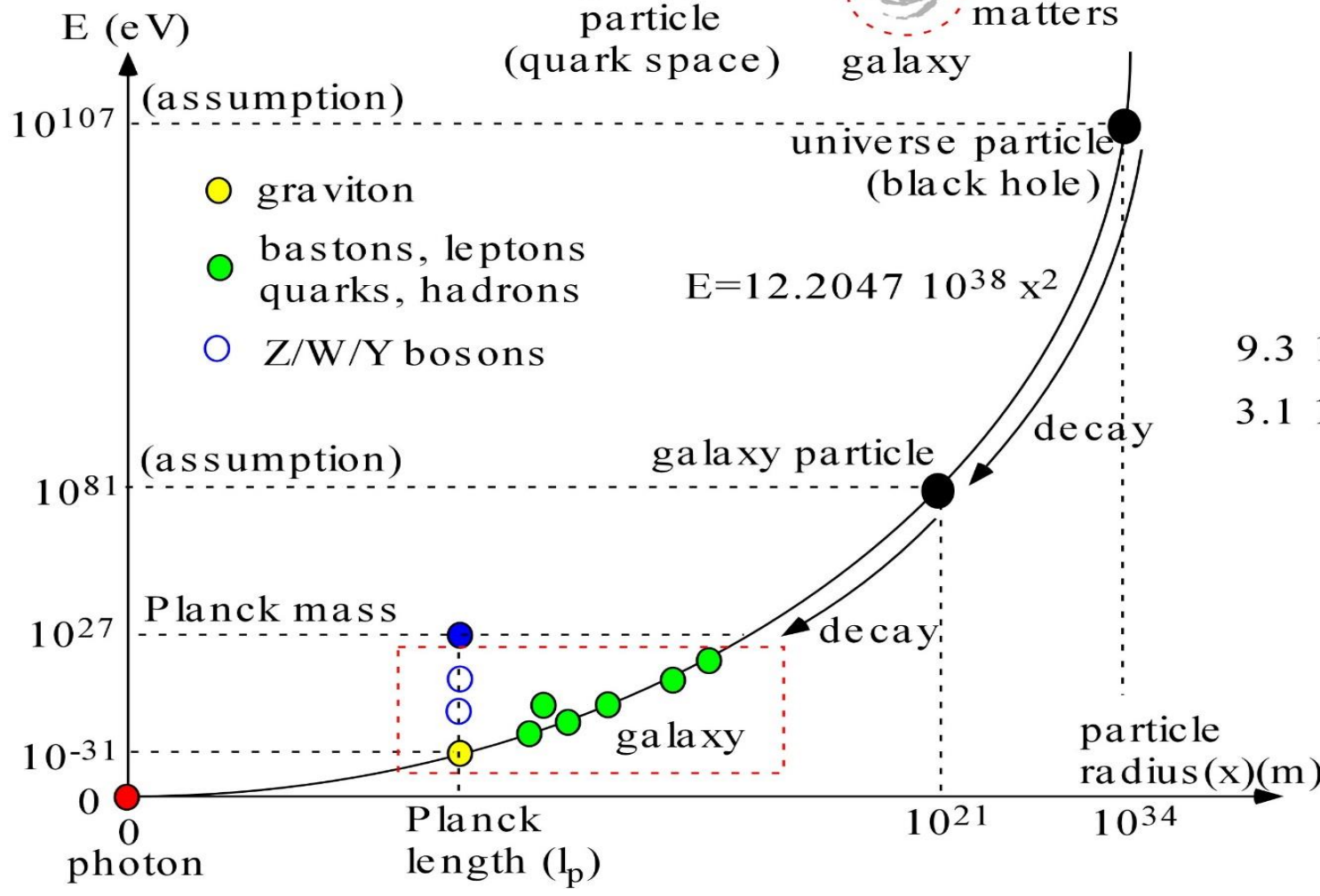
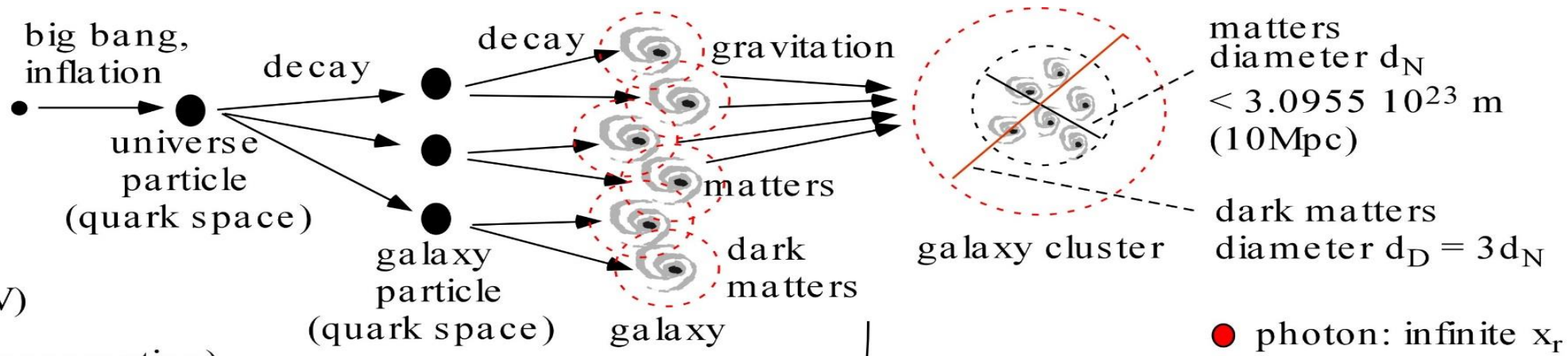


$Z(0) \longleftrightarrow Z(0,0) \longleftrightarrow Z(0,0,0)$: Force carrying bosons
 $\gamma(0) \not\longleftrightarrow \gamma(0,0) \not\longleftrightarrow \gamma(0,0,0)$: Charge dependent photons
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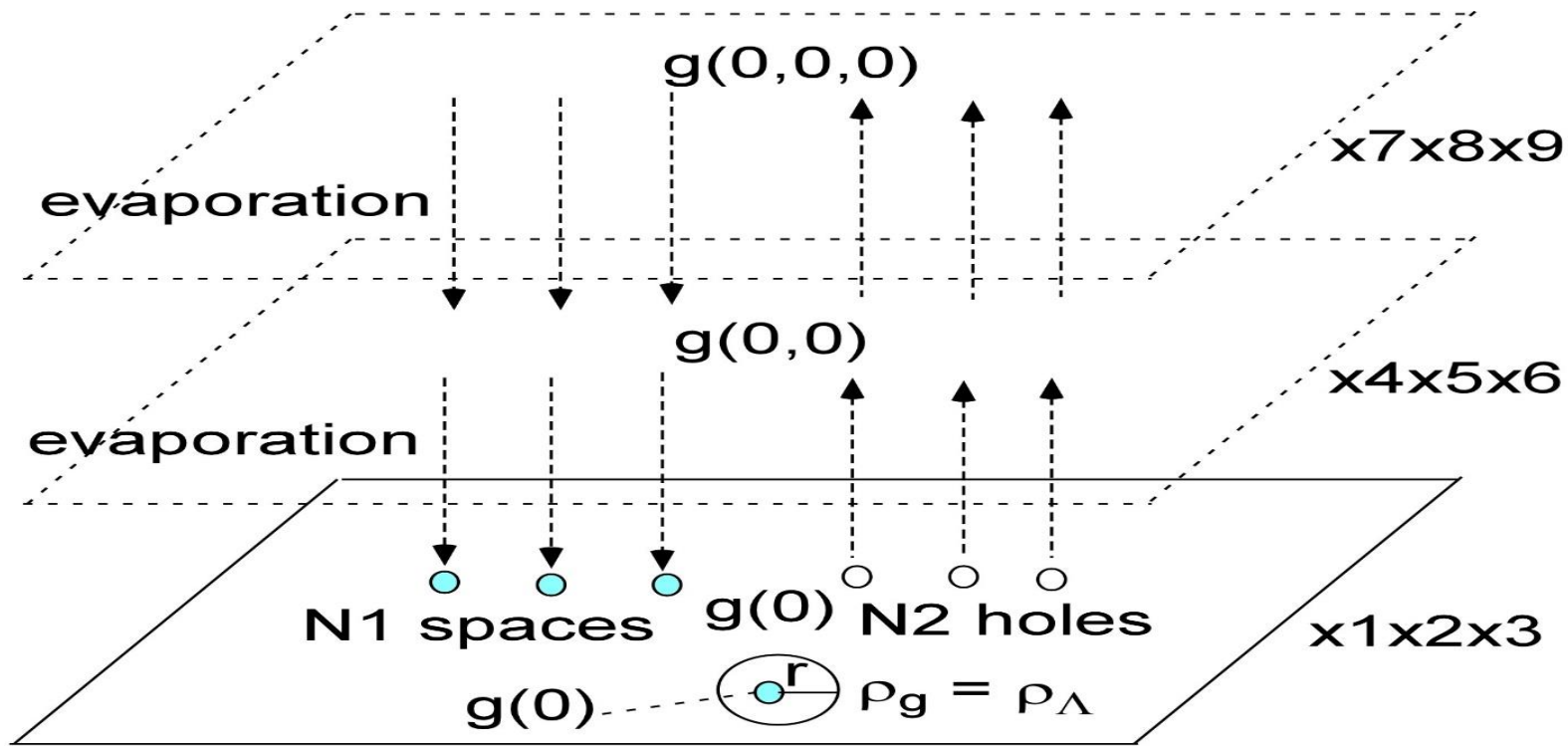
The baryons and mesons interact with the $g(0,0,0)$ quark graviton.

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 $E = 8.1365 \cdot 10^{38} x^2$ for the leptons ($\nu_e, \nu_\mu, \nu_\tau, e, \mu, \tau$) and $E = 12.2047 \cdot 10^{38} x^2$ for the quarks, baryons and mesons based on the measured size and energy of the proton [5].

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



● photon: infinite x_r



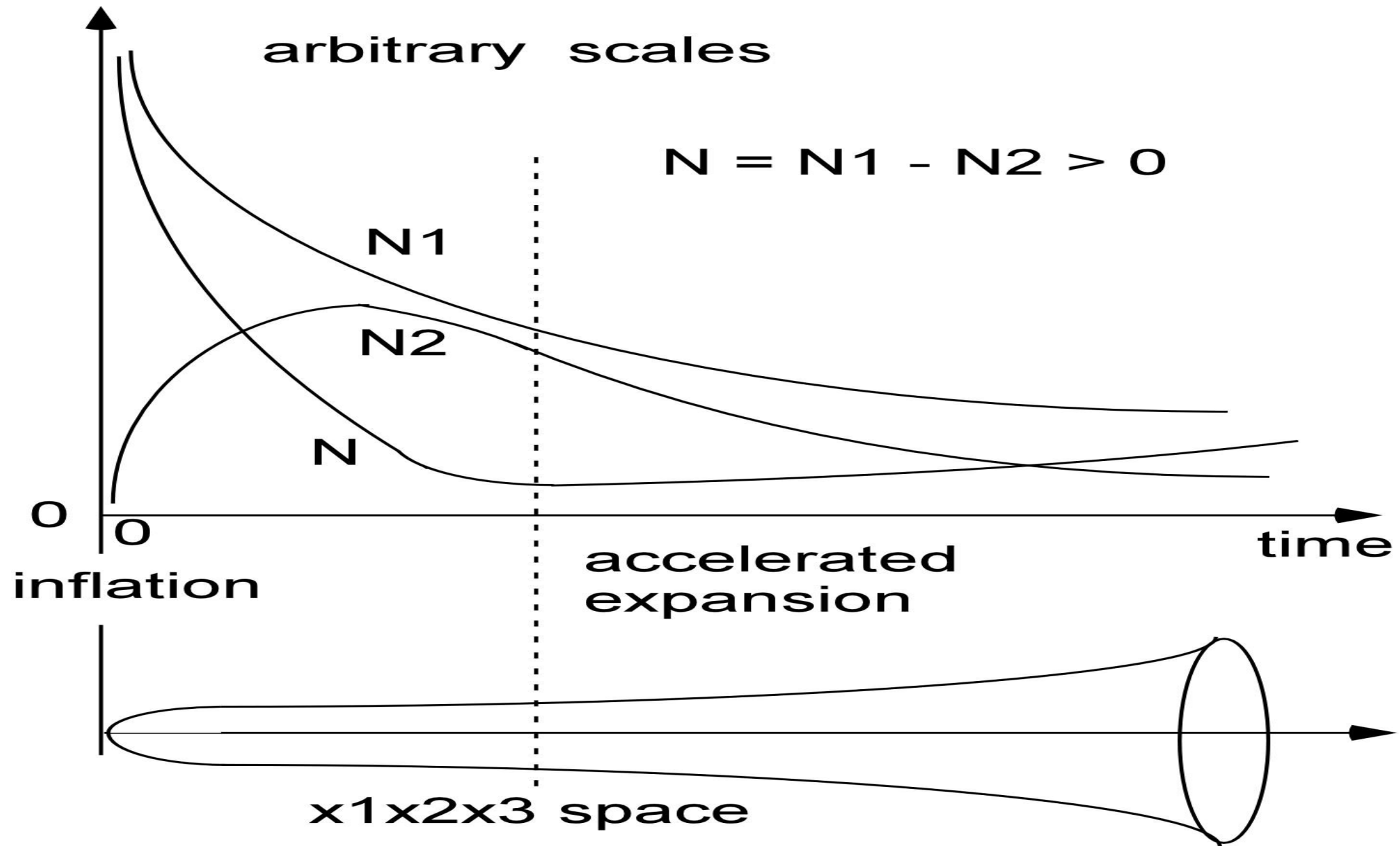
$g(0) \rightleftharpoons g(0,0) \rightleftharpoons g(0,0,0)$: evaporation

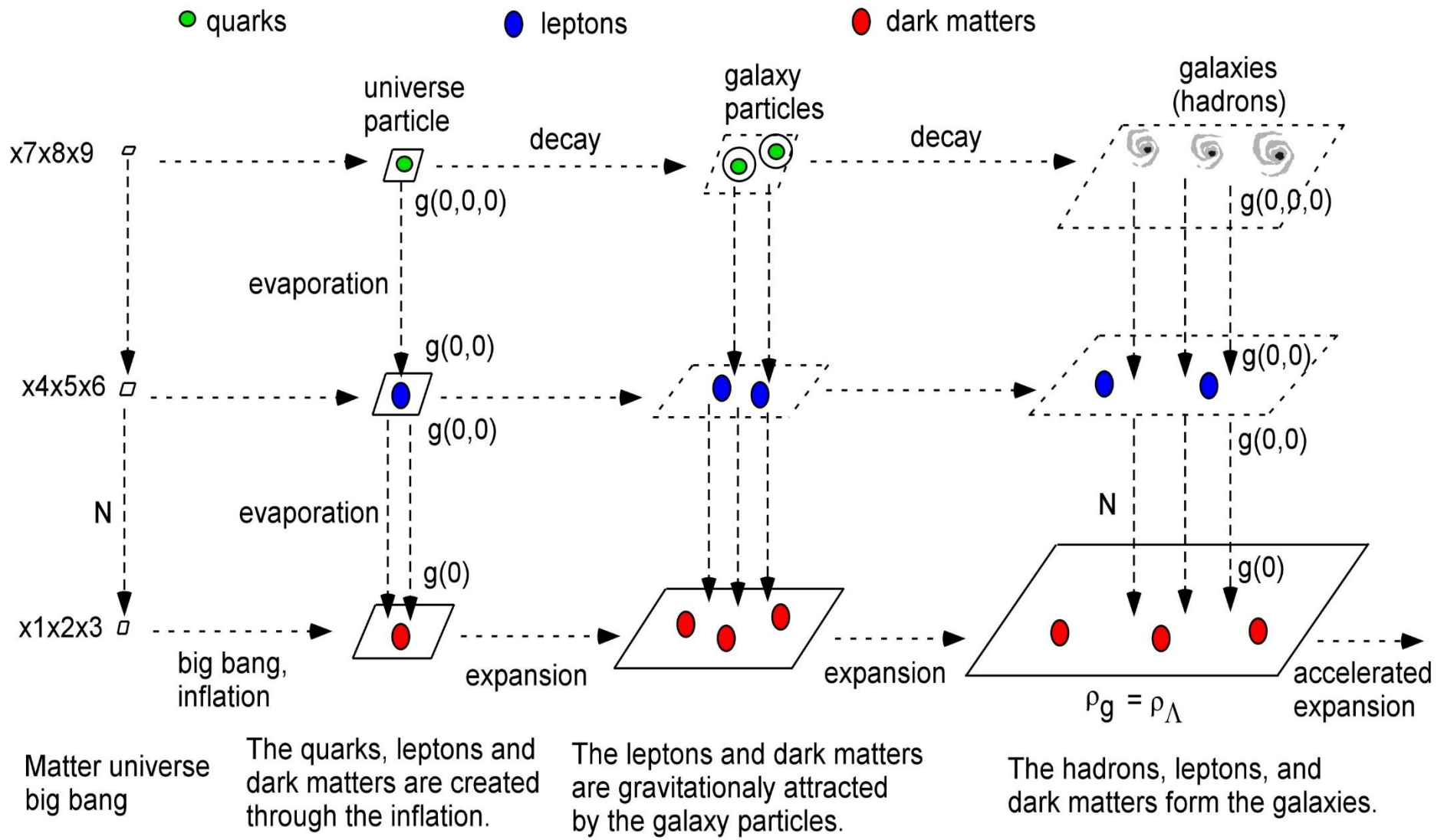
$N = N1 - N2$: number of new space quanta
 $x1x2x3$ space expansion if $N > 0$.

Accelerated $x1x2x3$ space expansion
 if $dN/dt > 0$.

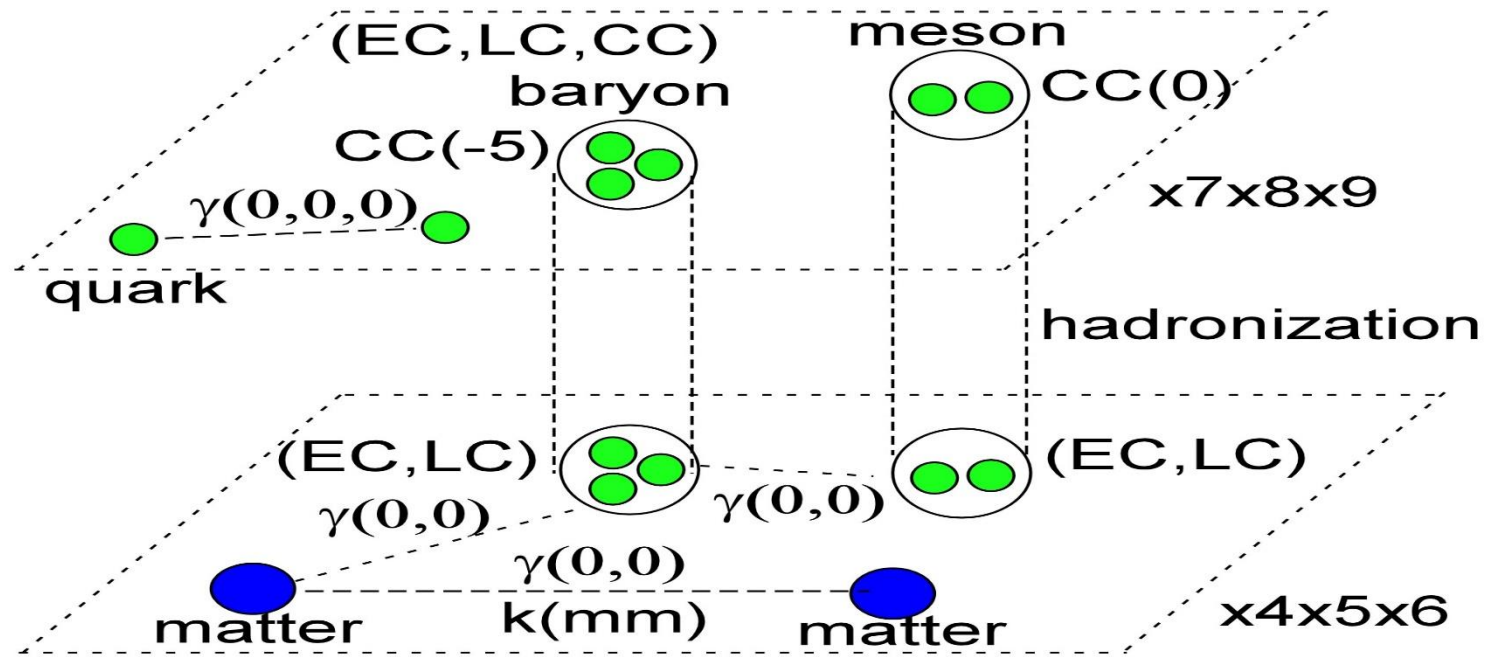
The $g(0)$ graviton is the $x1x2x3$ space quantum.
 The energy of these $g(0)$ gravitons is defined as
 the dark energy.

The $g(0)$ energy density (ρ_g) is the same as the
 dark energy density (ρ_Λ) measured from
 WMAP.

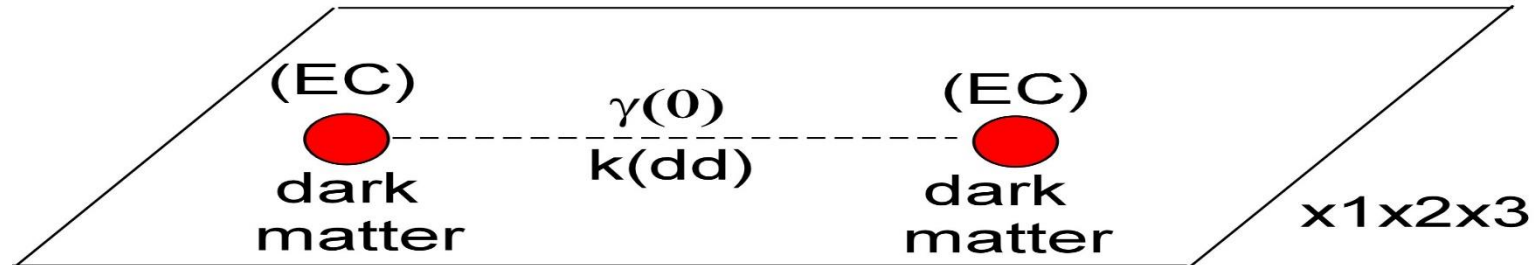




Note that an anti-matter partner universe big bang should take place in terms of the CP symmetry. The inflation and expansion of the $x1 \times 2 \times 3$ space are originated from the new spaces created by the evaporated gravitons into the $x1 \times 2 \times 3$ space and the repulsive electromagnetic force between dark matters corresponding to the dark energy.

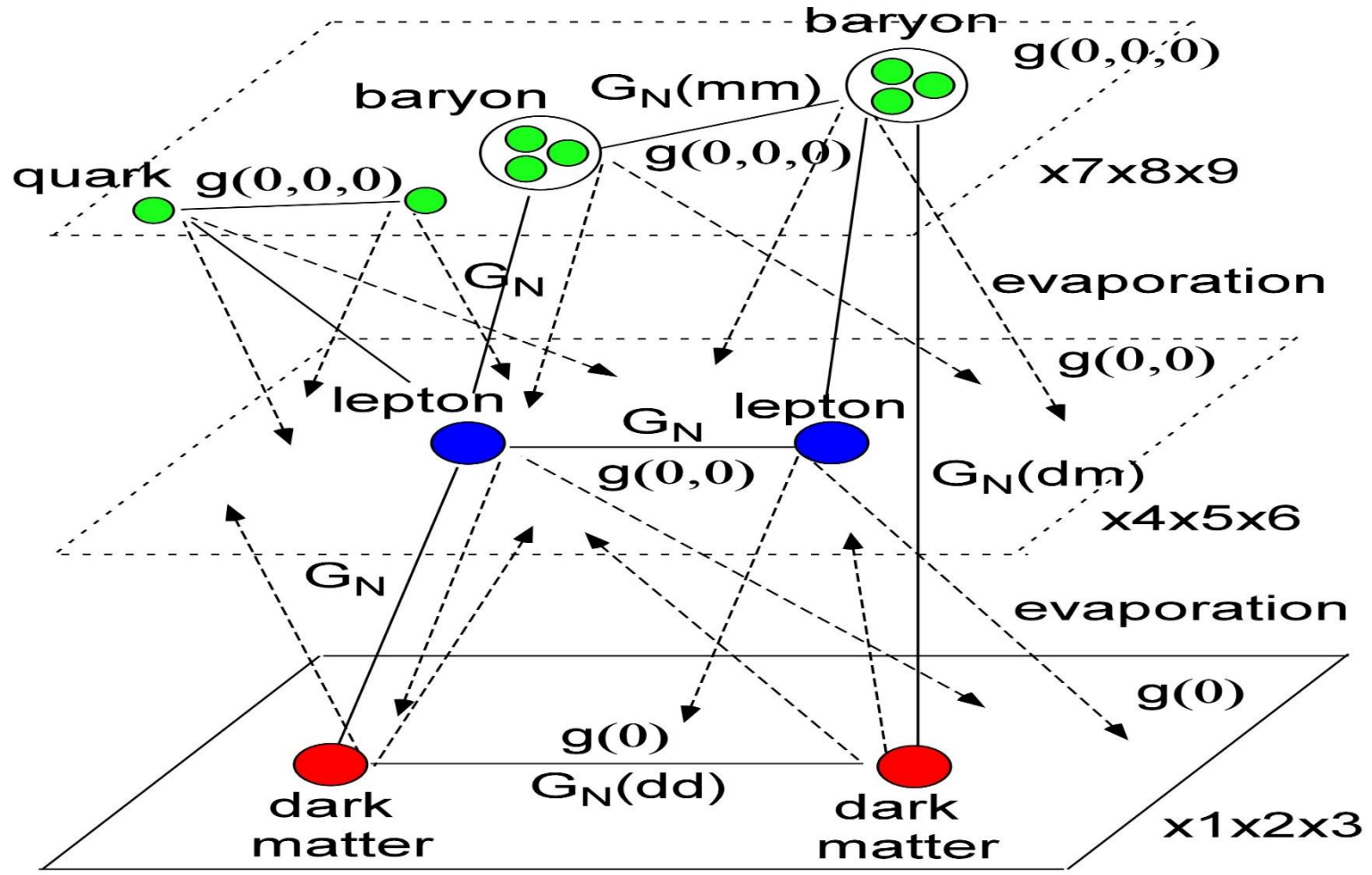


$k(dm) = 0, k(mm) \gg k(dd) : \text{Coulomb's constant}$



$\gamma(0) \longleftrightarrow \gamma(0,0) \longleftrightarrow \gamma(0,0,0) : \text{confinement}$

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



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

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

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	Z, W ⁻ , gluons (SM) →								0			
X8	Z(0,LC), W(-1,LC), Z(0,0,CC) (ESM)								-1			
X9	Z/W/Y(EC,LC,0) ↔ Z/W/Y(EC,LC)								-2			
Total	Z/W/Y(EC,0) ↔ Z/W/Y(EC)								-3			

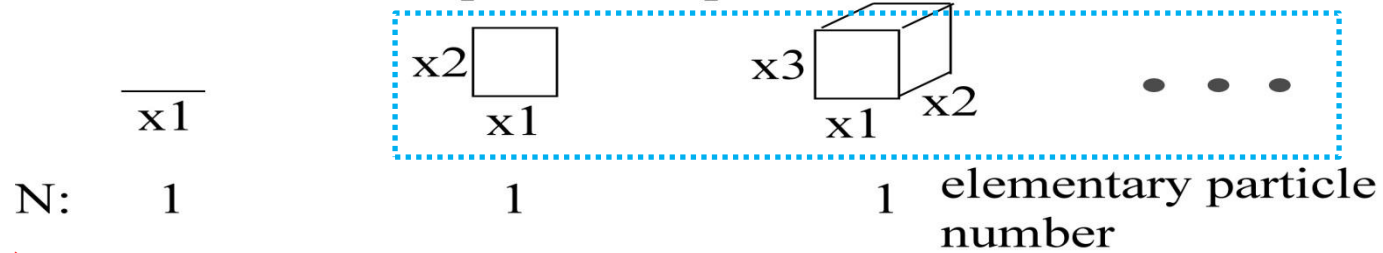
$$Z/W/Y(-1,0)CC(-2) = Z/W/Y(-1,0,-2)$$

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)
<p>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.</p>			

$x_1, x_2, x_3, x_4, x_5, x_6, x_7, \dots$

1 - dimensional quantized spaces

EC: x_1
 LC: x_2
 CC: x_3

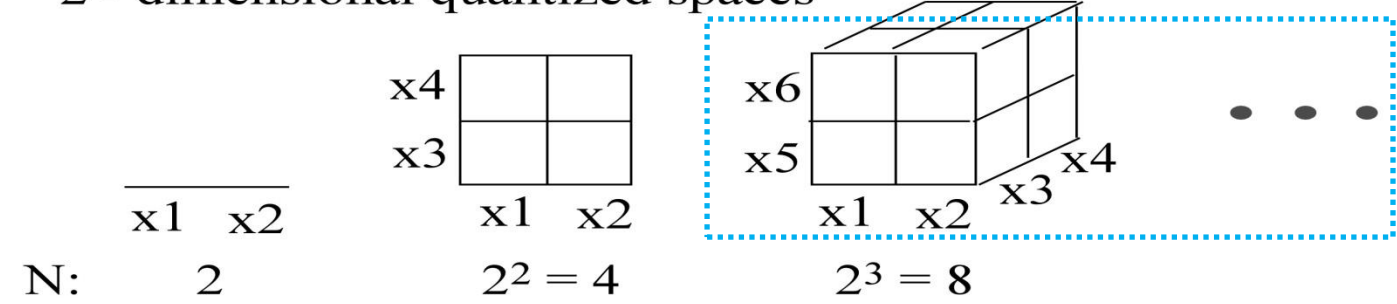


Each flavor (charge) corresponds to each dimensional axis.

$(x_1x_2), (x_3x_4), (x_5x_6), (x_7x_8), \dots$

2 - dimensional quantized spaces

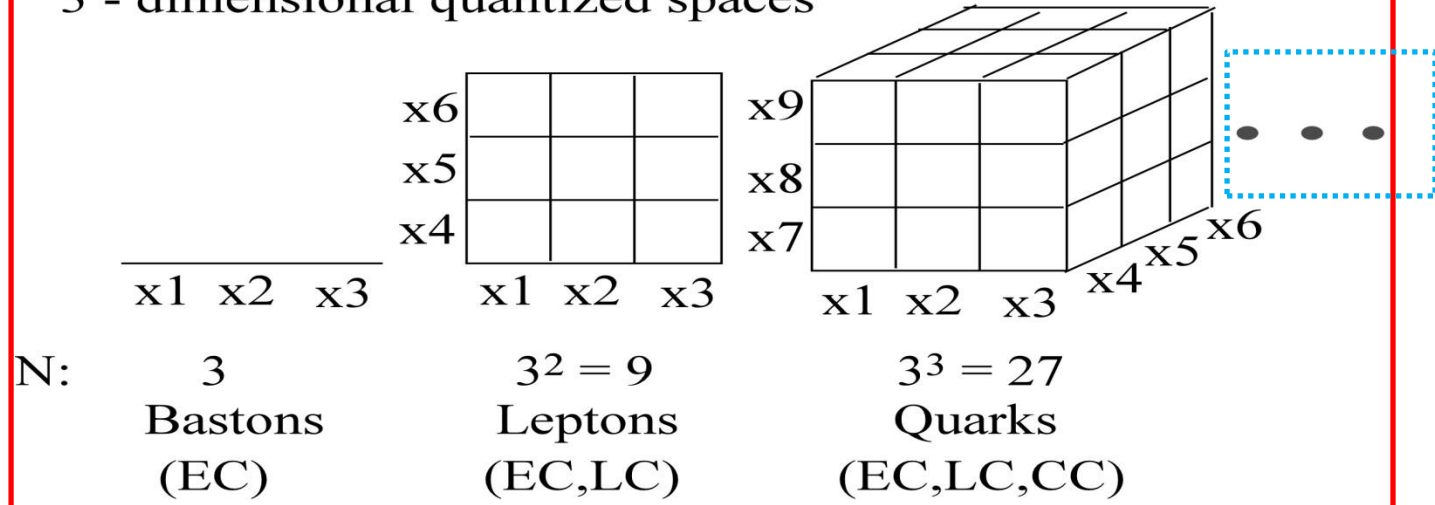
EC: x_1x_2
 LC: x_3x_4
 CC: x_5x_6



$(x_1x_2x_3), (x_4x_5x_6), (x_7x_8x_9), (x_{10},x_{11},x_{12}), \dots$

3 - dimensional quantized spaces

EC: $x_1x_2x_3$
 LC: $x_4x_5x_6$
 CC: $x_7x_8x_9$



: Excluded

$(x_1x_2x_3x_4), (x_5x_6x_7x_8), (x_9x_{10}x_{11}x_{12}), \dots$

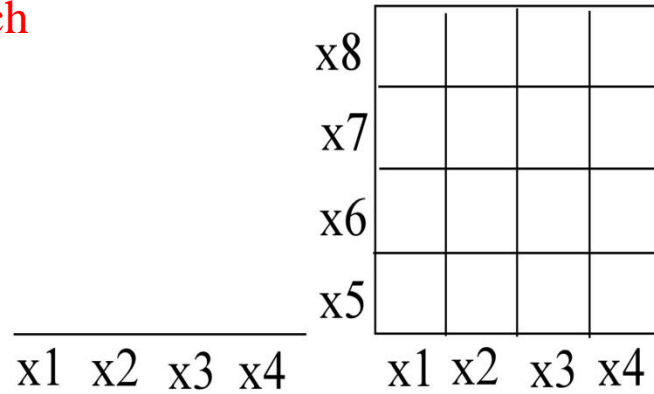
4 - dimensional quantized spaces

Each flavor (charge) corresponds to each dimensional axis.

EC: $x_1x_2x_3x_4$

LC: $x_5x_6x_7x_8$

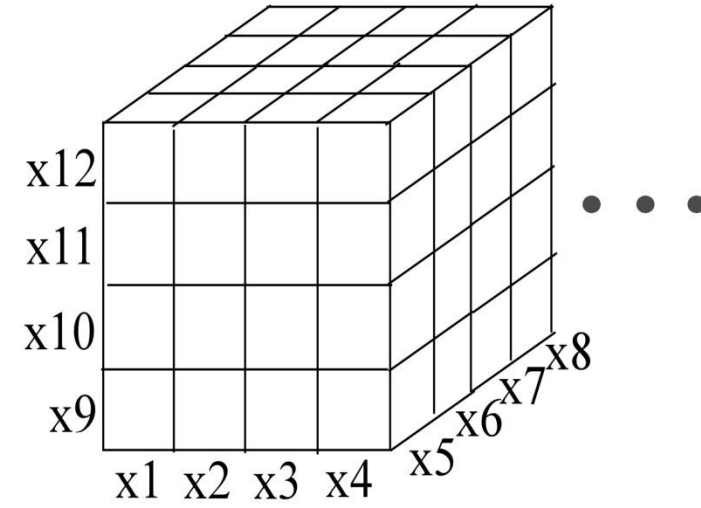
CC: $x_9x_{10}x_{11}x_{12}$



N:

4

$4^2 = 16$



$4^3 = 64$

$(x_1, x_2, x_3, x_4, x_5, x_6, x_7, \dots), \dots$

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, $4.27 \cdot 10^{10}$ and $1.9 \cdot 10^{15}$ 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, L_μ and L_τ .
- 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.