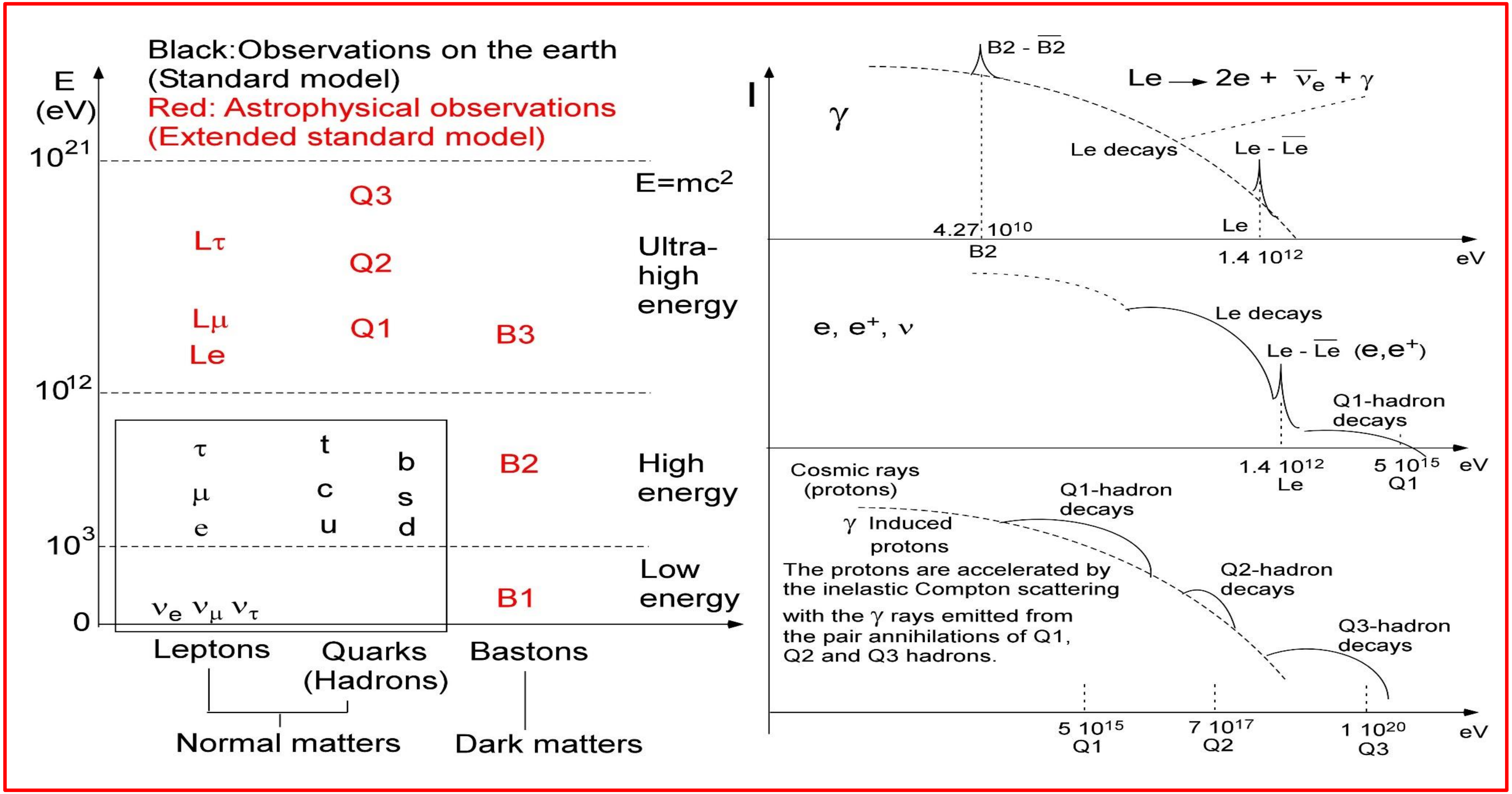
Charged dark matters, cosmic rays and extended standard model



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). The charged dark matters have the EC charges.
- The 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 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, talks at 2018 APS April meeting and Phenomenology 2018 symposium: https://indico.cern.ch/event/699148/contributions/2986365/attachments/1642260/2623270/Pheno18-Darkmatter-2018.pdf
[2] Jae-Kwang Hwang, Mod. Phys. Lett. **A32**, 1730023 (2017).
[3] J.K. Hwang, https://www.researchgate.net/publication/325761228 (2018).
[4] J.K. Hwang, https://www.researchgate.net/publication/325200286 (2018).

- 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 these cosmic X-rays supports the presence of the Q1 quark with the EC of -4e/3. These data support the existence of heavy quarks like Q1, Q2 and Q3.
- 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.

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 (flavor), (Important) CC: Color charge

1. Standard model (SM),

Leptons (EC,LC) and
Quarks (EC,LC,CC)

For EC

γ: zero rest mass
long range force
EM force (EC)

Z, W^+, W^- : non-zero rest mass
short range force
weak force (EC)

Electric charge (EC) (q):
QED

Quarks (EC,LC,CC)

For CC

Gluons:
zero rest mass
short range force
asymptotic freedom
strong force (CC)

Color charges (CC) (r,g,b):
QCD

Leptons (EC,LC) and
Quarks (EC,LC,CC)

For LC

Bosons: Missing
Lepton charge force
(LC) (Missing)

Lepton charges (LC)
(flavors ?):
QFD Missing

EC, LC and CC charges are separated for bosons and intertwined for fermions.

EC: Electric charge, LC: Lepton charge (flavor), CC: Color charge

1. Standard model (SM),

No dark matters are assigned.

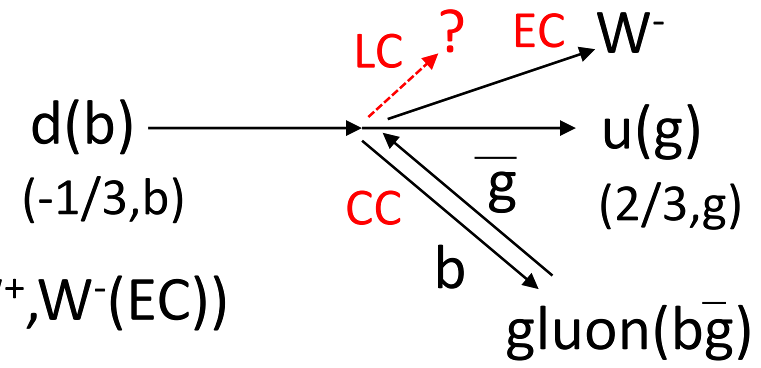
lepton(EC,LC) → lepton(LC) → No Force (?)

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))



EC, LC and CC charges are separated for bosons and intertwined for fermions.

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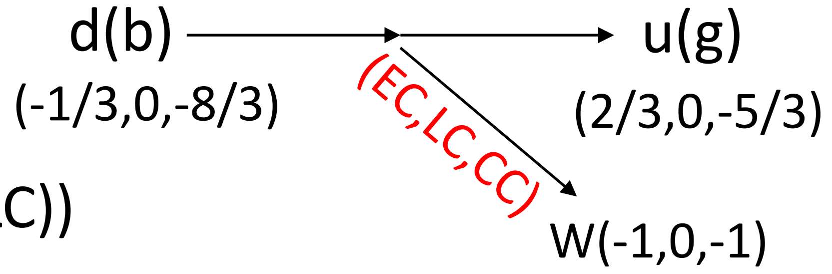
2. Extended standard model (ESM),

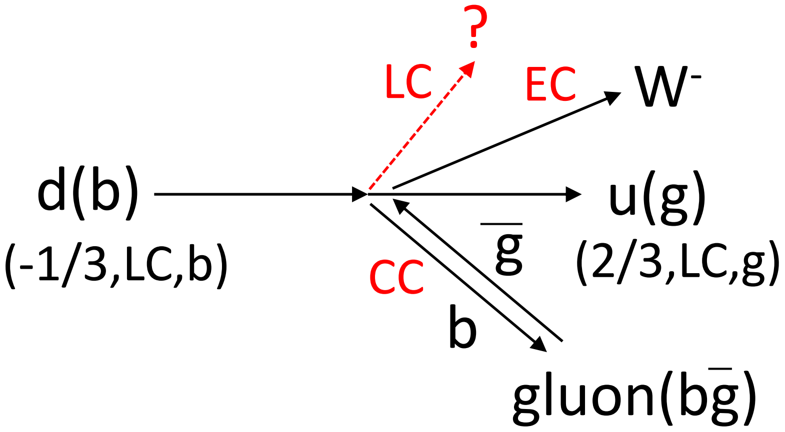
	long range force	short range force
lepton(EC,LC) → / baryon(EC,LC) →	EM force (γ(0,0)),	weak force (Z/W/Y(EC,LC))
quark(EC,LC,CC) →	EM force (γ(0,0,0)),	strong force (Z/W/Y(EC,LC,CC))
baston(EC) (dark matter) →	EM force (γ(0)),	dark matter force (Z/W/Y(EC))

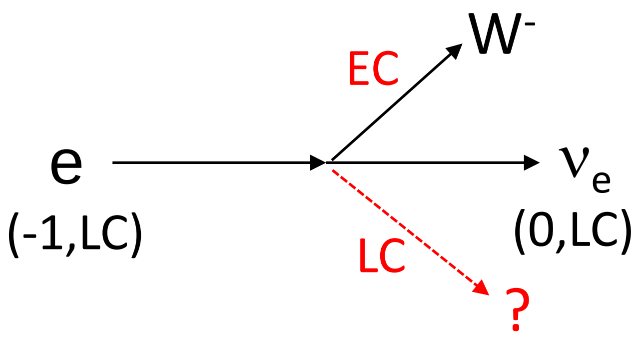


Coulomb's constant
k(mm) >> k(dd)
γ(0,0) γ(0)

EC, LC and CC charges are intertwined for both of bosons and fermions.

1. Standard model (SM), (short range force)





No dark matters

EC, LC and CC charges are separated for bosons and intertwined for fermions.

Bosons (?) associated with LC are missing.

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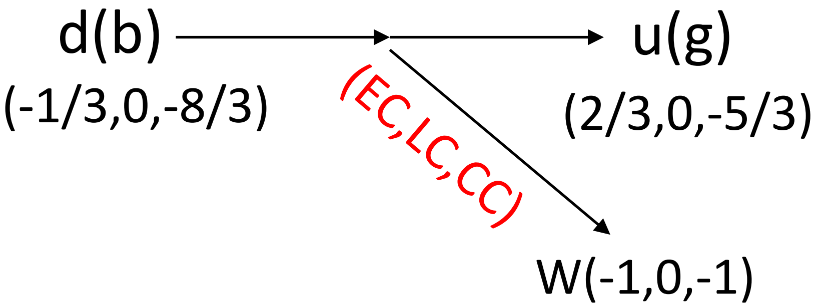
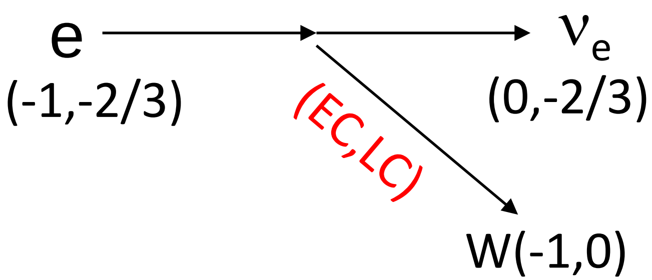
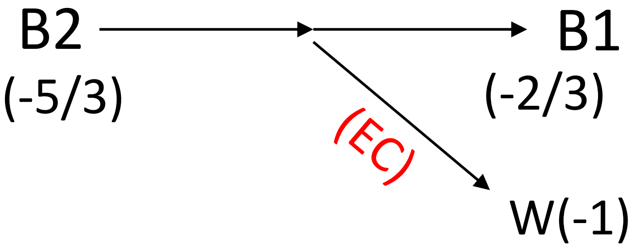
2. Extended standard model (ESM),



Strong force boson



Weak force boson



Dark matter force boson (Very weak force)

EC, LC and CC charges are intertwined for both of bosons and fermions.

1. Standard model (SM), (Photons)

EC γ (QED)
k
LC ?
d(b) u(g)
(-1/3,LC,b) (2/3,LC,g)
CC
gluons (QCD)

k
EC γ (QED)
e LC ? μ
(-1,LC) (-1,LC)

Coulomb's constant
k(mm: γ) = k(dd: γ) = k

No dark matters

EC, LC and CC charges are separated for photons and intertwined for fermions.

Photons (QFD) (?) associated with LC are missing. QFD: quantum flavor dynamics

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2. Extended standard model (ESM),

Coulomb's constant
k(mm: γ(0,0)) = k >> k(dd: γ(0)) > 0

(EC,LC,CC)
d(b) ⟷ u(g)
(-1/3,0,-8/3) γ(0,0,0) (2/3,0,-5/3)
k(qq)
Unobservable photon
(quarks)

(EC,LC)
e ⟷ μ
(-1,-2/3) γ(0,0) (-1,-5/3)
k(mm)
Normal photon
(leptons, hadrons)

(EC)
B2 ⟷ B1
(-5/3) γ(0) (-2/3)
k(dd)
Dark photon
(Very weak force)
(dark matters)

EC, LC and CC charges are intertwined for photons and fermions.

γ(0,0,0) ⟷X⟷ γ(0,0) ⟷X⟷ γ(0)

1. Standard model (SM), (Gravitons)

Gravitation constant
G(mm:g) = G(dd:g) = G_N

$d(b) \xleftrightarrow[G_N]{g} u(g)$
(-1/3,LC,b) (2/3,LC,g)

$e \xleftrightarrow[G_N]{g} \mu$
(-1,LC) (-1,LC)

No dark matters

EC, LC and CC charges are intertwined for fermions,
but the graviton is not associated with the EC, LC and CC charges.

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2. Extended standard model (ESM),

Gravitation constant
$G_N(mm{:}g(0,0,0)) = G_N < G_N(dd{:}g(0))$

$d(b) \xleftrightarrow[g(0,0,0)]{(EC,LC,CC)} u(g)$
(-1/3,0,-8/3) (2/3,0,-5/3)
G_N(mm)

Unobservable graviton
(quarks,hadrons)

$e \xleftrightarrow[g(0,0)]{(EC,LC)} \mu$
(-1,-2/3) (-1,-5/3)
G_N(ll)

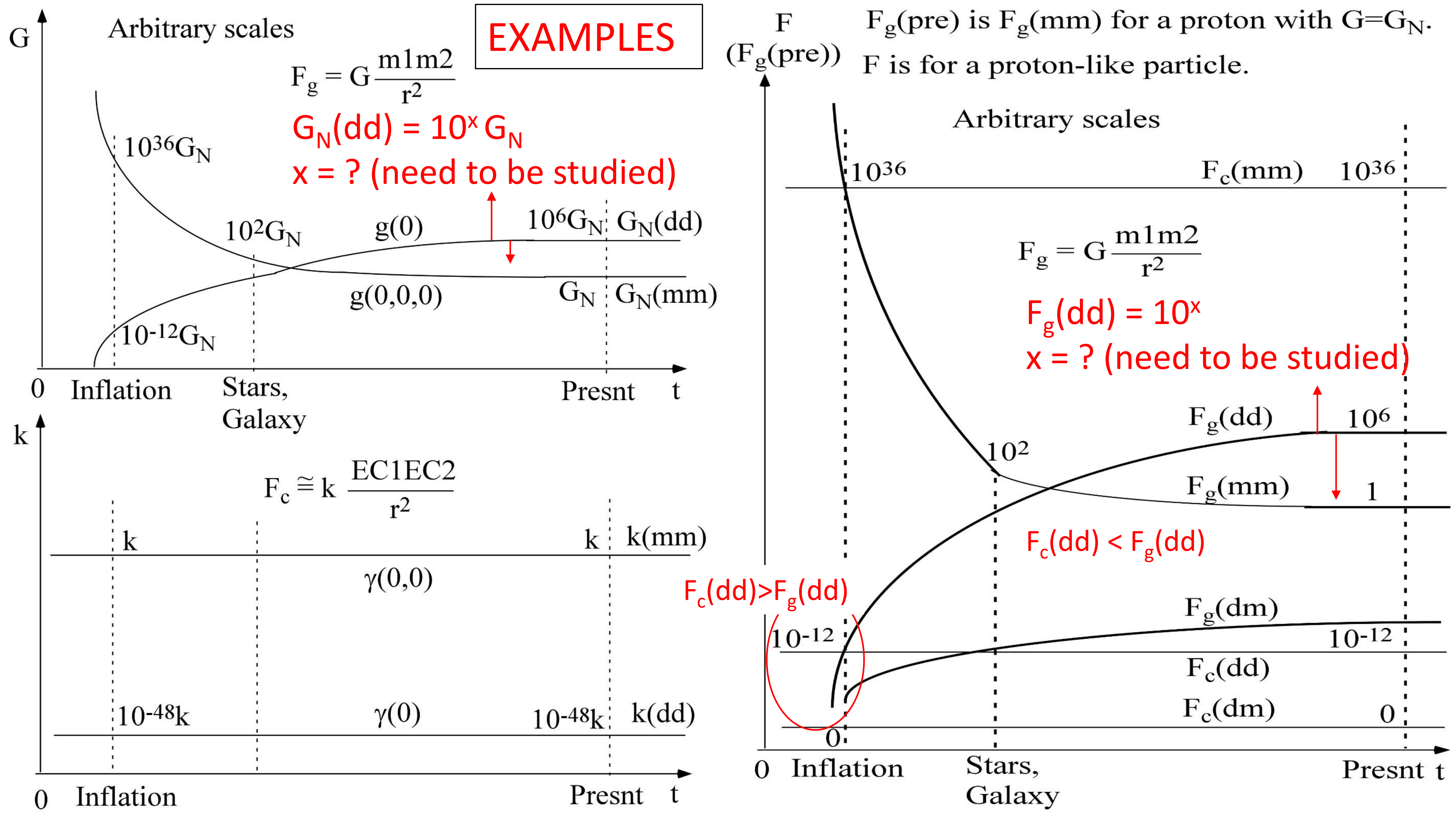
Normal graviton
(leptons)

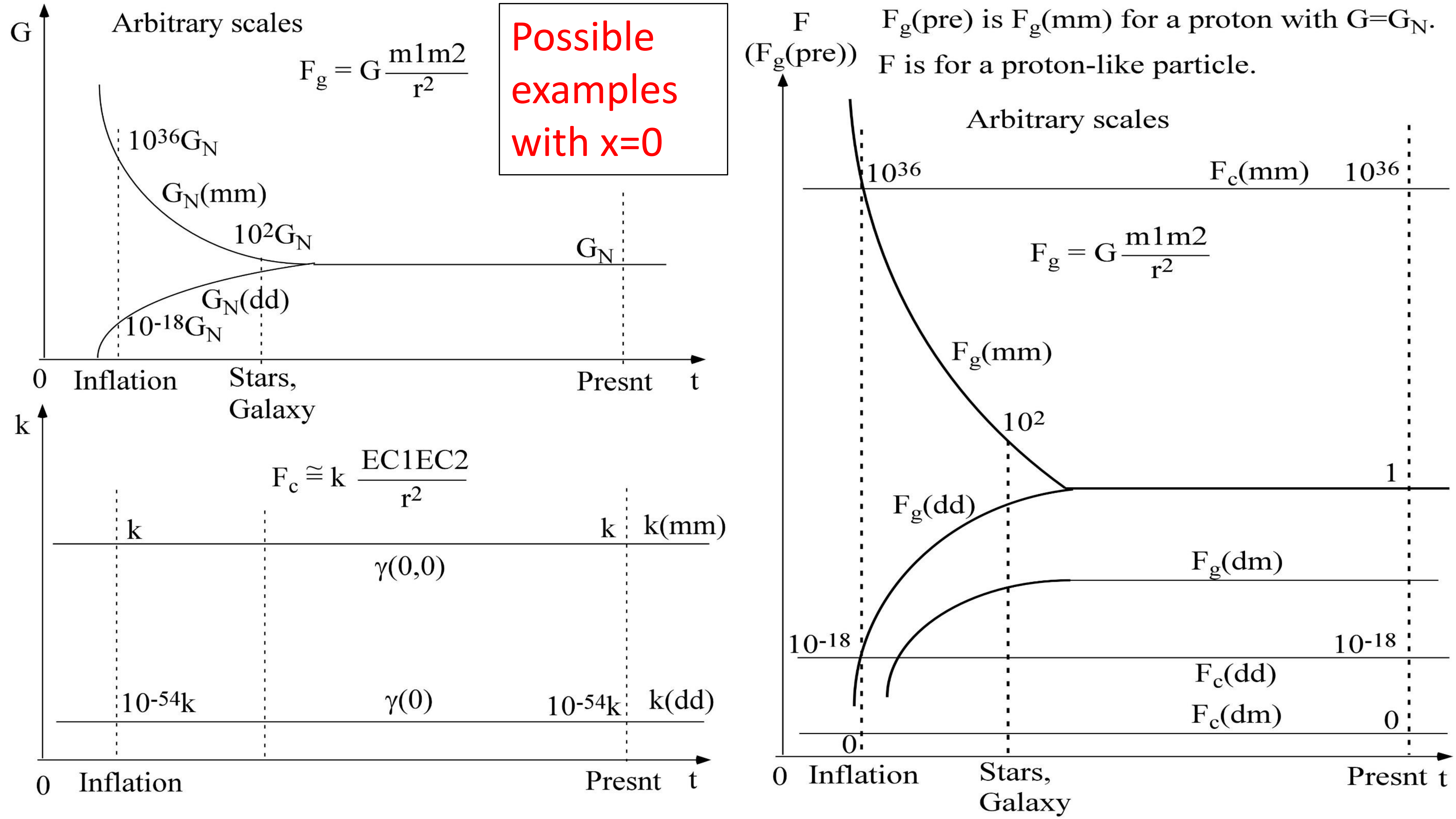
$B2 \xleftrightarrow[g(0)]{(EC)} B1$
(-5/3) (-2/3)
G_N(dd)

Dark graviton
(dark matters)

EC, LC and CC charges are intertwined
for gravitons and fermions.

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


EXAMPLES
G
Arbitrary scales
Fg = G m1m2/r2
GN(dd) = 10x GN
x = ? (need to be studied)
1036GN
102GN
g(0)
106GN
GN(dd)
g(0,0,0)
GN
GN(mm)
10-12GN
0
Inflation
Stars, Galaxy
Presnt
t
k
Fc ≅ k EC1EC2/r2
k
k
k(mm)
γ(0,0)
10-48k
γ(0)
10-48k
k(dd)
0
Inflation
Presnt
t
F
(Fg(pre))
Fg(pre) is Fg(mm) for a proton with G=GN.
F is for a proton-like particle.
Arbitrary scales
1036
Fc(mm)
1036
Fg = G m1m2/r2
Fg(dd) = 10x
x = ? (need to be studied)
Fg(dd)
106
102
Fg(mm)
1
Fc(dd) < Fg(dd)
Fc(dd)>Fg(dd)
Fg(dm)
10-12
10-12
Fc(dd)
Fc(dm)
0
0
0
Inflation
Stars, Galaxy
Presnt
t


Possible examples with x=0
G
Arbitrary scales
$F_g = G\frac{m1m2}{r^2}$
$10^{36}G_N$
$G_N(mm)$
10^2G_N
G_N
$G_N(dd)$
$10^{-18}G_N$
0
Inflation
Stars, Galaxy
Presnt
t
k
$F_c \cong k\frac{EC1EC2}{r^2}$
k
k
k(mm)
γ(0,0)
$10^{-54}k$
γ(0)
$10^{-54}k$
k(dd)
0
Inflation
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}
$F_g = G\frac{m1m2}{r^2}$
$F_g(mm)$
10^2
1
$F_g(dd)$
$F_g(dm)$
10^{-18}
10^{-18}
$F_c(dd)$
$F_c(dm)$
0
0
0
Inflation
Stars, Galaxy
Presnt
t

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

	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			

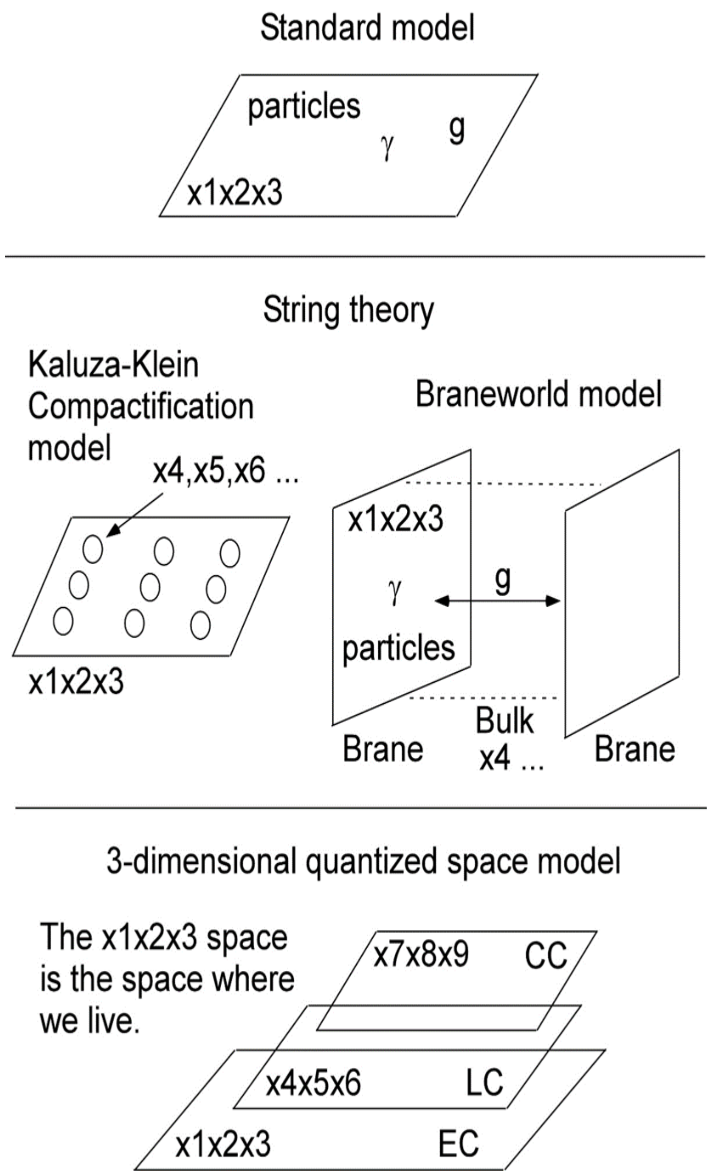
Dark matters

-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



Coulomb's constant k(mm) >> k(dd)

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.

	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			

Each flavor (charge) corresponds to each dimensional axis.

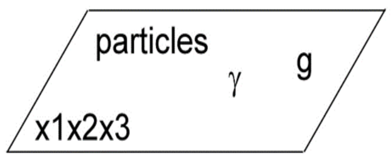
Z, W-, gluons (SM) → Z(0,LC),W(-1,LC), Z(0,0,CC) (ESM)

Z/W/Y(EC,LC,0) ⟷ Z/W/Y(EC,LC)

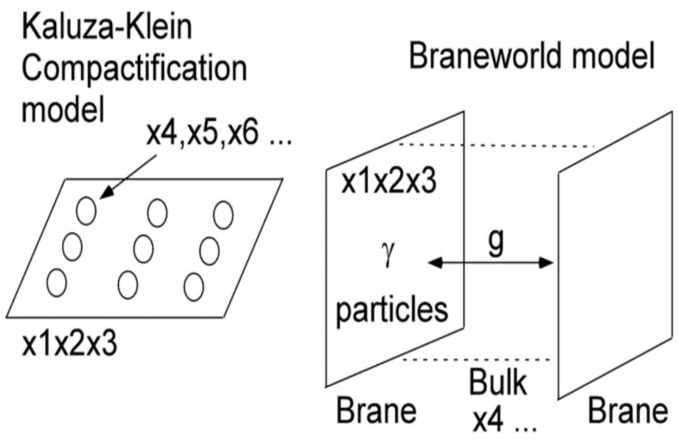
Z/W/Y(EC,0) ⟷ Z/W/Y(EC)

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

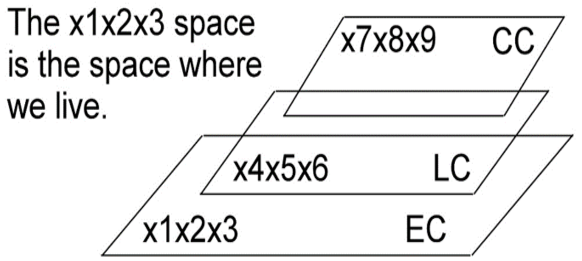
Standard model



String theory

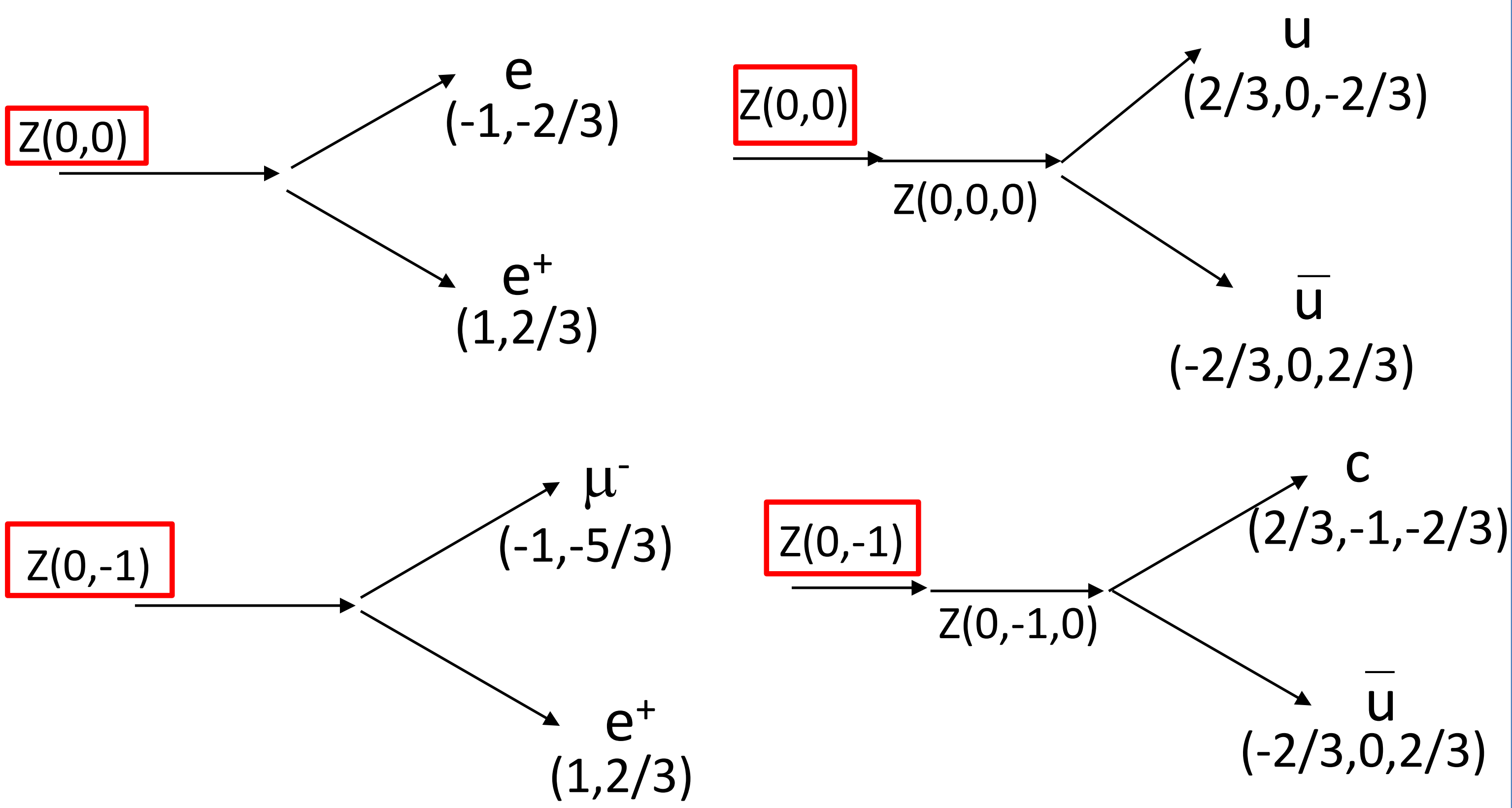


3-dimensional quantized space model

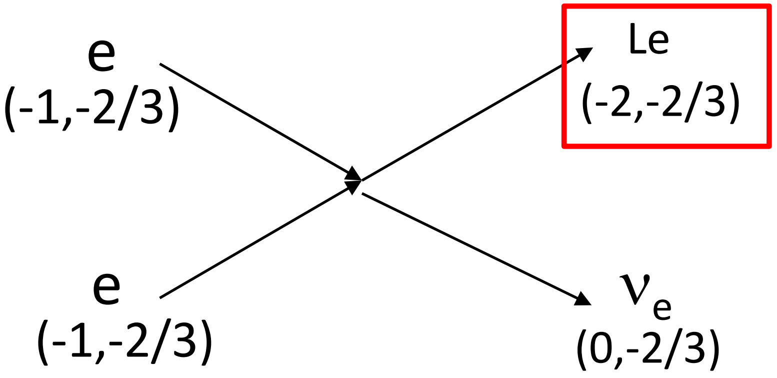


Coulomb's constant
k(mm) >> k(dd)

Z' boson problem Z → Z(0,0), Z' → Z(0,-1)



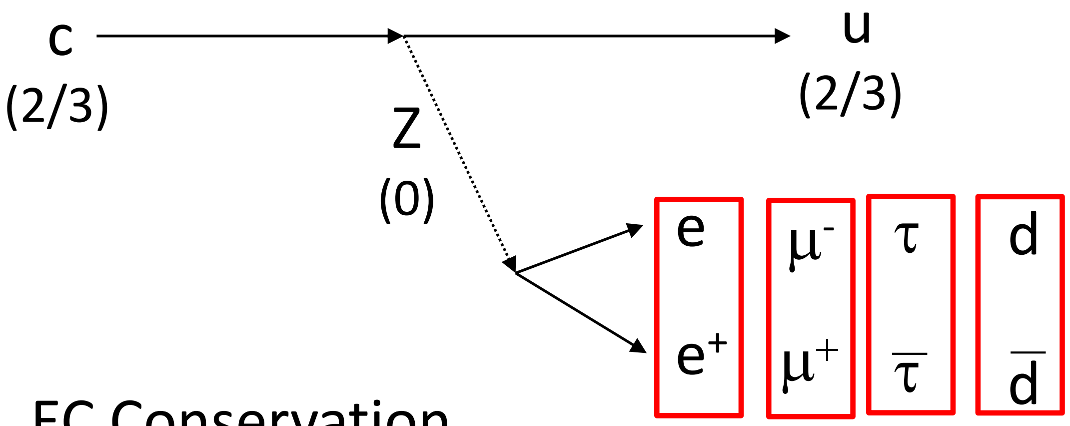
Le lepton production



Rest mass of Le lepton could be 1.4 TeV/c^2 from cosmic ray observations.

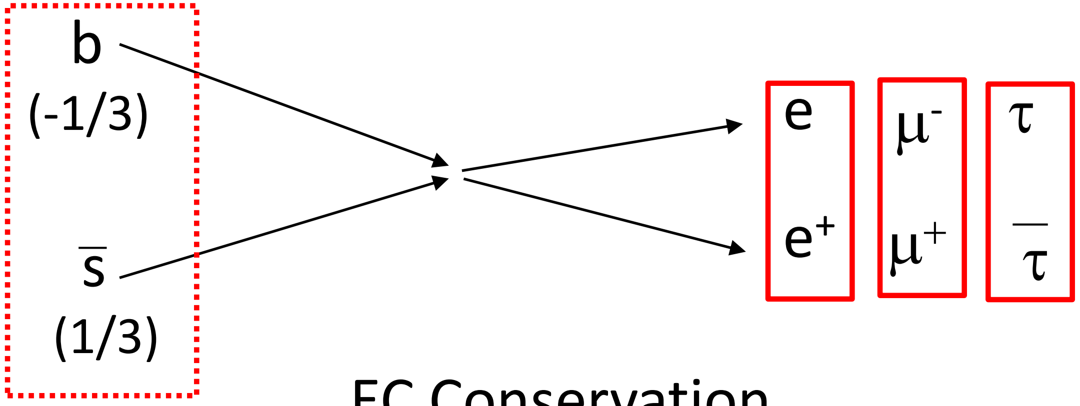
Z(0,-1)) boson can be observed in the decay channels like $\mu^- - e^+$, c - $\bar{u}$ and $\tau - \mu^+$ but not in the decay channels like $e - e^+$, u - $\bar{u}$ and $\tau - \bar{\tau}$.

Standard Model (SM)



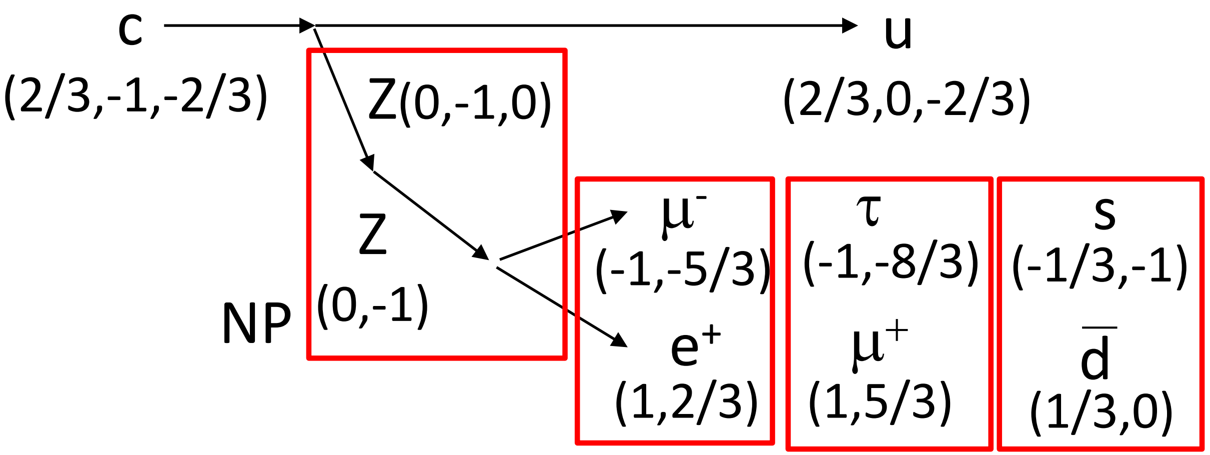
EC Conservation.
LC is not conserved.

Standard Model (SM)



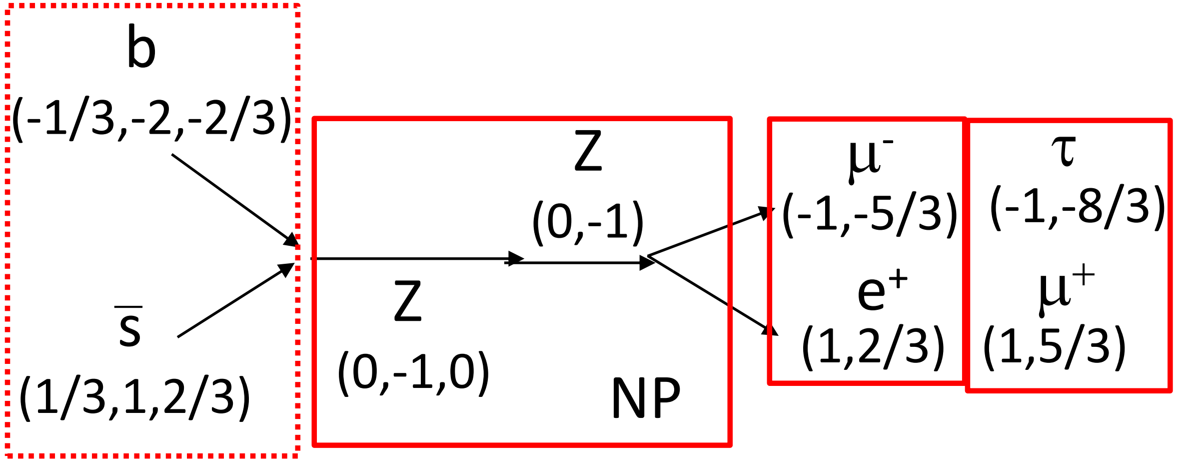
EC Conservation.
LC is not conserved.

Extended Standard Model (ESM)



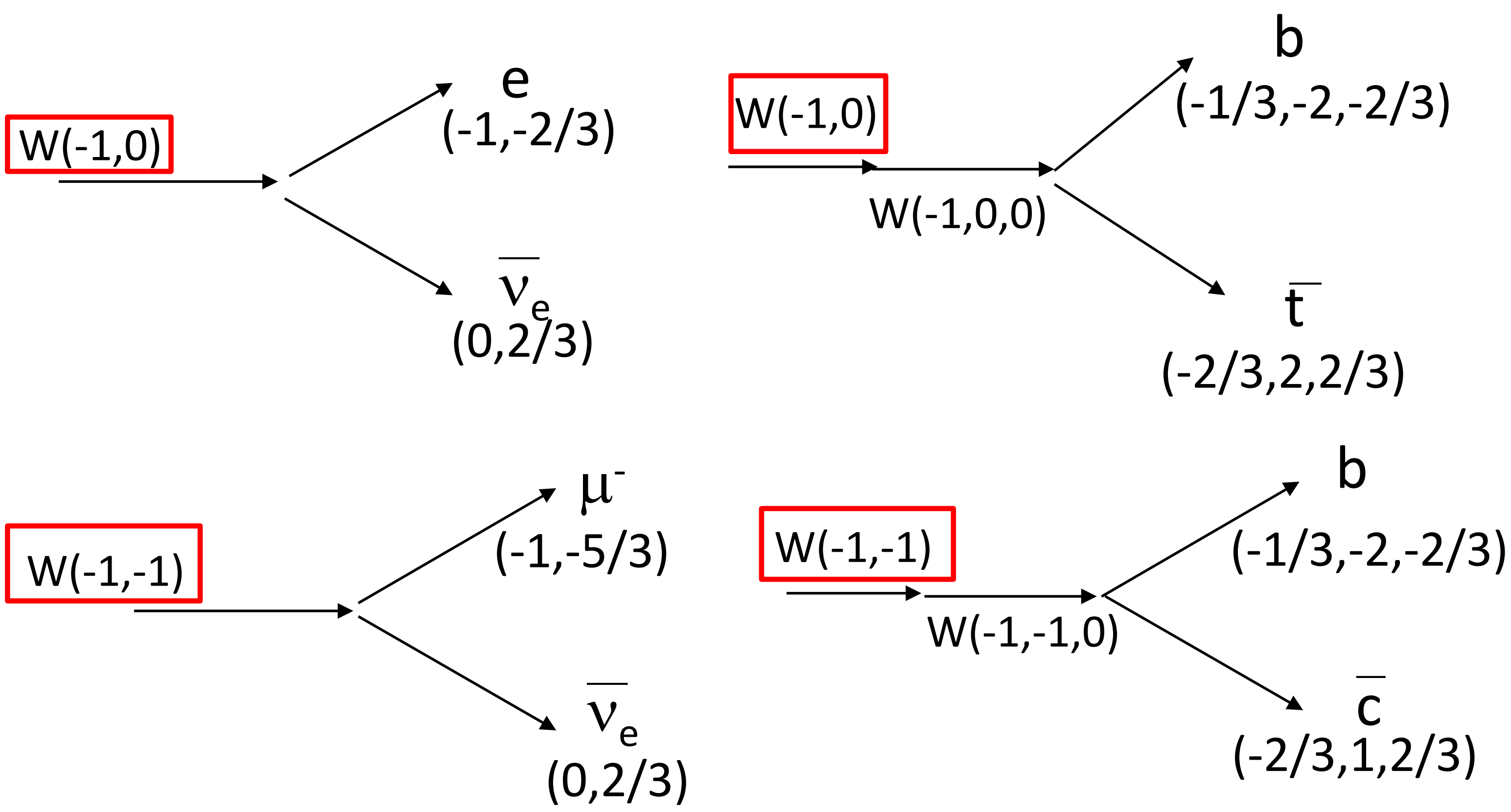
EC, LC and CC Conservations.

Extended Standard Model (ESM)



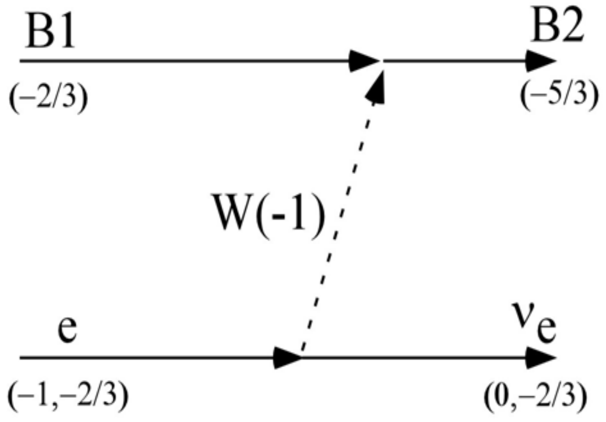
EC, LC and CC Conservations.

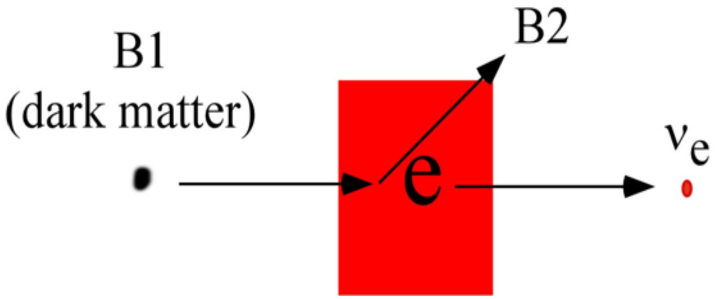
W' boson problem $W^- \longrightarrow W(-1,0)$, $W' \longrightarrow W(-1,-1)$



W(-1,-1)) boson can be observed in the decay channels like $\mu^- - \bar{\nu}_e$, b - $\bar{c}$ and s – $\bar{u}$.

Dark matter reactions

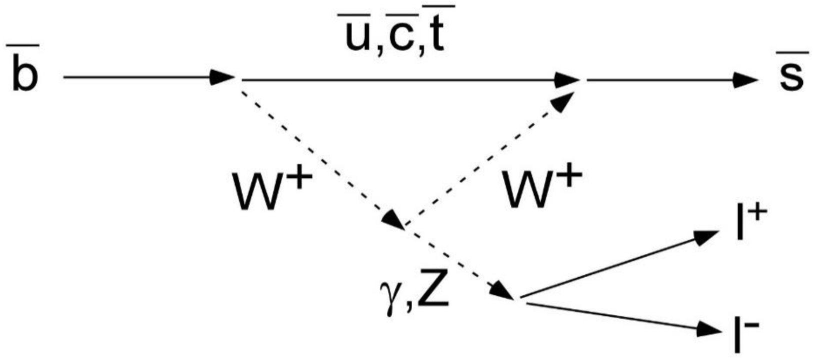




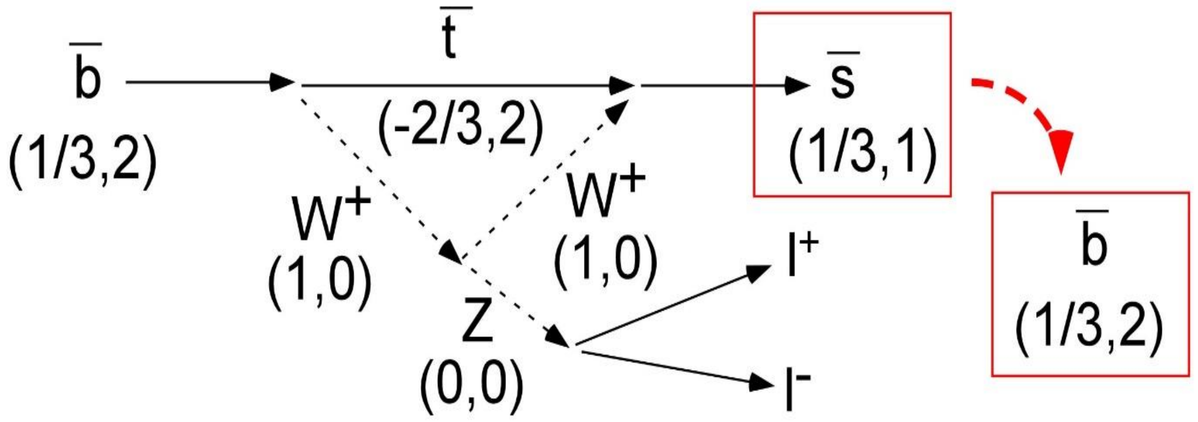
Enhanced neutrinos can be observed in LHC and in cosmic ray.

SM (Standard Model)

R_K Anomaly	LHC data	SM
$R_K = B(B \to K\mu^+\mu^-)/B(B \to Ke^+e^-)$	0.745	1
$R_{K^*} = B(B \to K^*\mu^+\mu^-)/B(B \to K^*e^+e^-)$	0.685	1



EC(Electric Charge) conservation
LC (Lepton Charge) is not conserved.

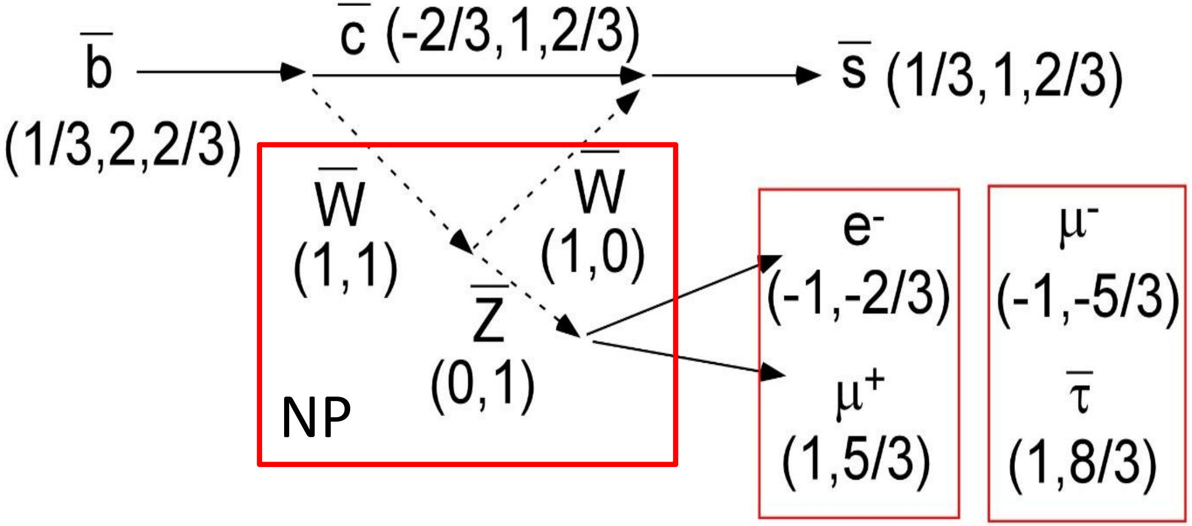


EC(Electric Charge) conservation
LC (Lepton Charge) is not conserved.

New Physics (NP)

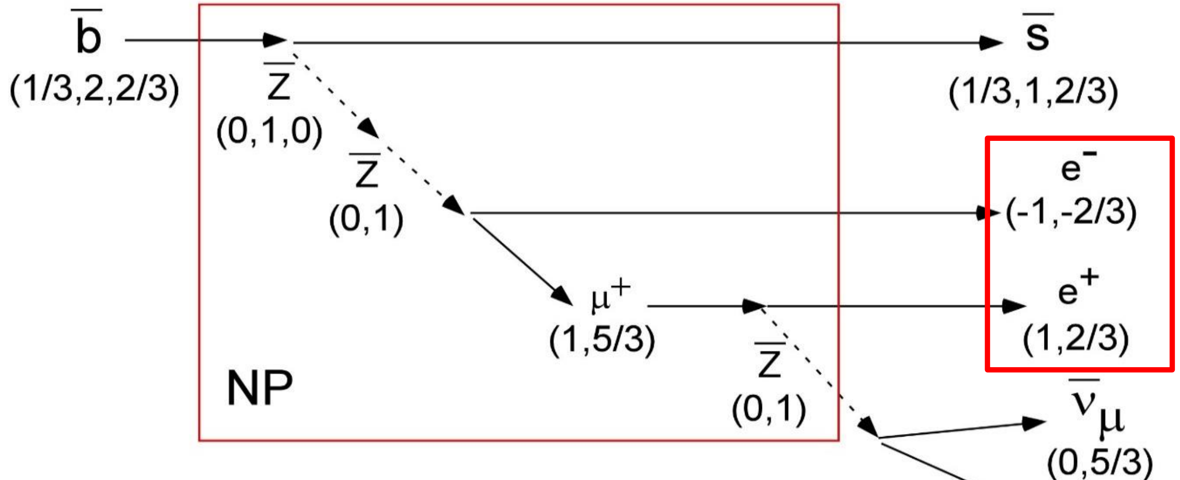
LHC data:
B. Capdevila et al., arXiv: 1704.05340 (2017).

New Physics (NP) - Extended standard model

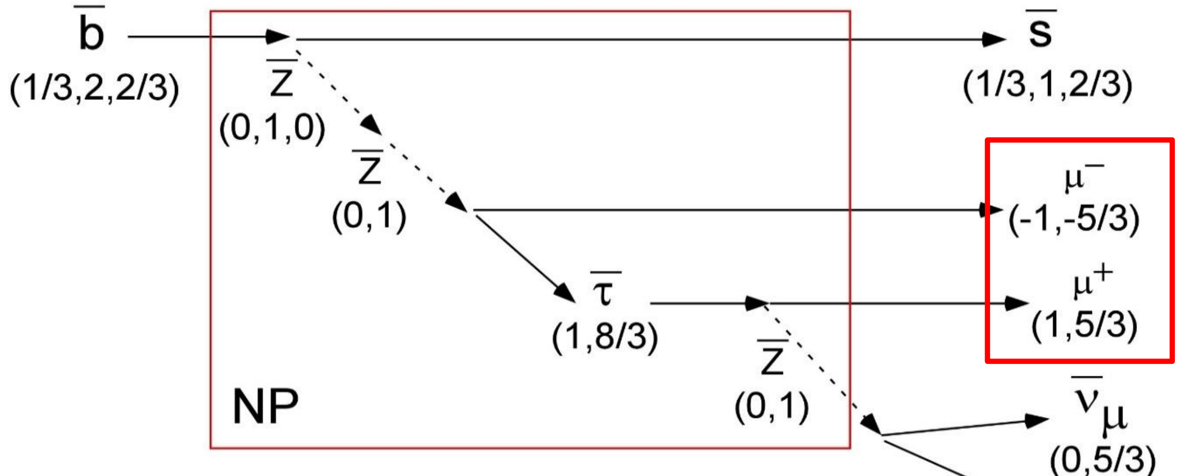


EC, LC and CC(Color charge) conservations.

ESM (Extended Standard Model)



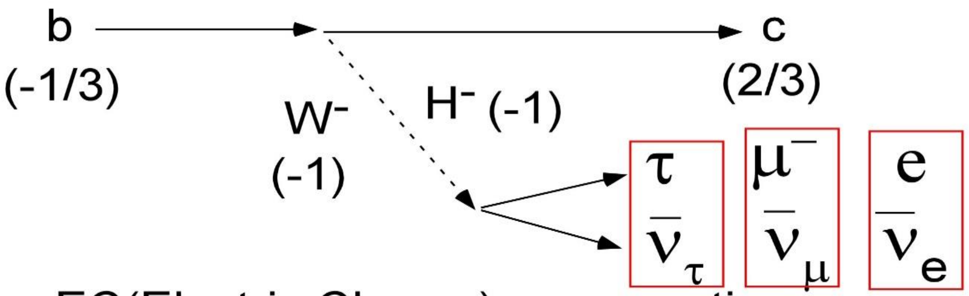
Two different decay modes support that R_K is not 1 but 0.745 from LHC data.



EC(Electric Charge),
LC(Lepton Charge) and
CC(Color Charge) conservations

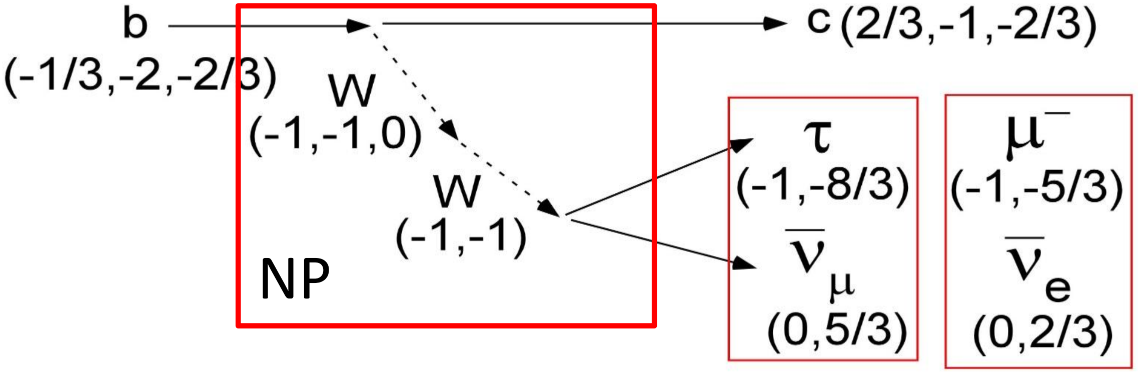
SM (Standard Model)

R_D Anomaly	BABAR data	SM
$R_D = B(B\rightarrow D\,\tau\,\bar{\nu})/B(B\rightarrow D\,l\,\bar{\nu})$	0.440	0.297
$R_{D^*} = B(B\rightarrow D^*\,\tau\,\bar{\nu})/B(B\rightarrow D^*\,l\,\bar{\nu})$	0.332	0.252



EC(Electric Charge) conservation
LC (Lepton Charge) is not conserved.

New Physics (NP) - Extended standard model



EC, LC and CC(Color charge) conservations.

BABAR data: J.P. Lees et al., arXiv:1303.0571v1 (2013).

Origin problem of the cosmic ray anti-Helium events

Six anti-^{3}He cosmic ray events and two anti-^{4}He cosmic ray events were observed by AMS-02 measurements.

Q1 baryon (Q,R baryons) decays (present work)

$$N(Q1,u,u)(0,0,-5) \longrightarrow p + e + \bar{\nu}_e \text{ (Favored)}$$
$$R(Q1,d,u)(-1,0,-5) \longrightarrow p + 2e + 2\bar{\nu}_e \text{ (Favored)}$$
$$pR \longrightarrow pp + 2e + 2\bar{\nu}_e \longrightarrow {}^2He + 2\bar{\nu}_e$$
$$pR \longrightarrow pn + e + \bar{\nu}_e \longrightarrow d + \bar{\nu}_e$$
$$ppQ \longrightarrow ppn + 2e + 2\bar{\nu}_e \longrightarrow {}^3He + 2\bar{\nu}_e \text{ (Favored)}$$
$$ppRR \longrightarrow ppnn + 2e + 2\bar{\nu}_e \longrightarrow {}^4He + 2\bar{\nu}_e$$

Enhanced anti- ^{3}He events are originated from the anti- (ppQ) decay.

This supports the existence of the new heavy Q1, Q2 and Q3 quarks

Anti-matter clouds and anti-matter stars are proposed by Poulin et al. as their origins.

V. Poulin et al., “Where do the AMS-02 anti-helium events come from?” arXiv:1808.08961v1 (2018).

Origin problem of the missing neutrinos

Hadronization (Leptonization)

Baryon(EC,LC,-5) ⟶ Baryon(EC,LC) CC(-5)

Meson(EC,LC,0) ⟶ Meson(EC,LC) CC(0)

Lepton1 - Hadron2: $F_{12} = F_{12}(EC) + F_{12}(LC)$

Hadron1 - Hadron2: $F_{12} = F_{12}(EC) + F_{12}(LC) + F_{12}(CC)$

Examples;

u(2/3,0.-2/3) - s(-1/3,-1,-5/3): $F_{12} = \frac{1}{4\pi r^2}\left(\frac{(-3/9)}{\varepsilon_0(EC)} + \frac{(10/3)}{\varepsilon_0(CC)}\right)$

e(-1,-2/3) - p(1,0): $F_{12} = \frac{-1}{4\pi r^2 \varepsilon_0(EC)}$ Coulomb Force

ν_e(0,-2/3) - e(-1,-2/3): $F_{12} = \frac{(4/9)}{4\pi r^2 \varepsilon_0(LC)}$ Lepton charge Force

The weak lepton charge interactions could explain the missing neutrinos observed at the solar neutrino experiments, atmospheric neutrino experiments and nuclear reactor neutrino experiments.

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, Lμ, Lτ)

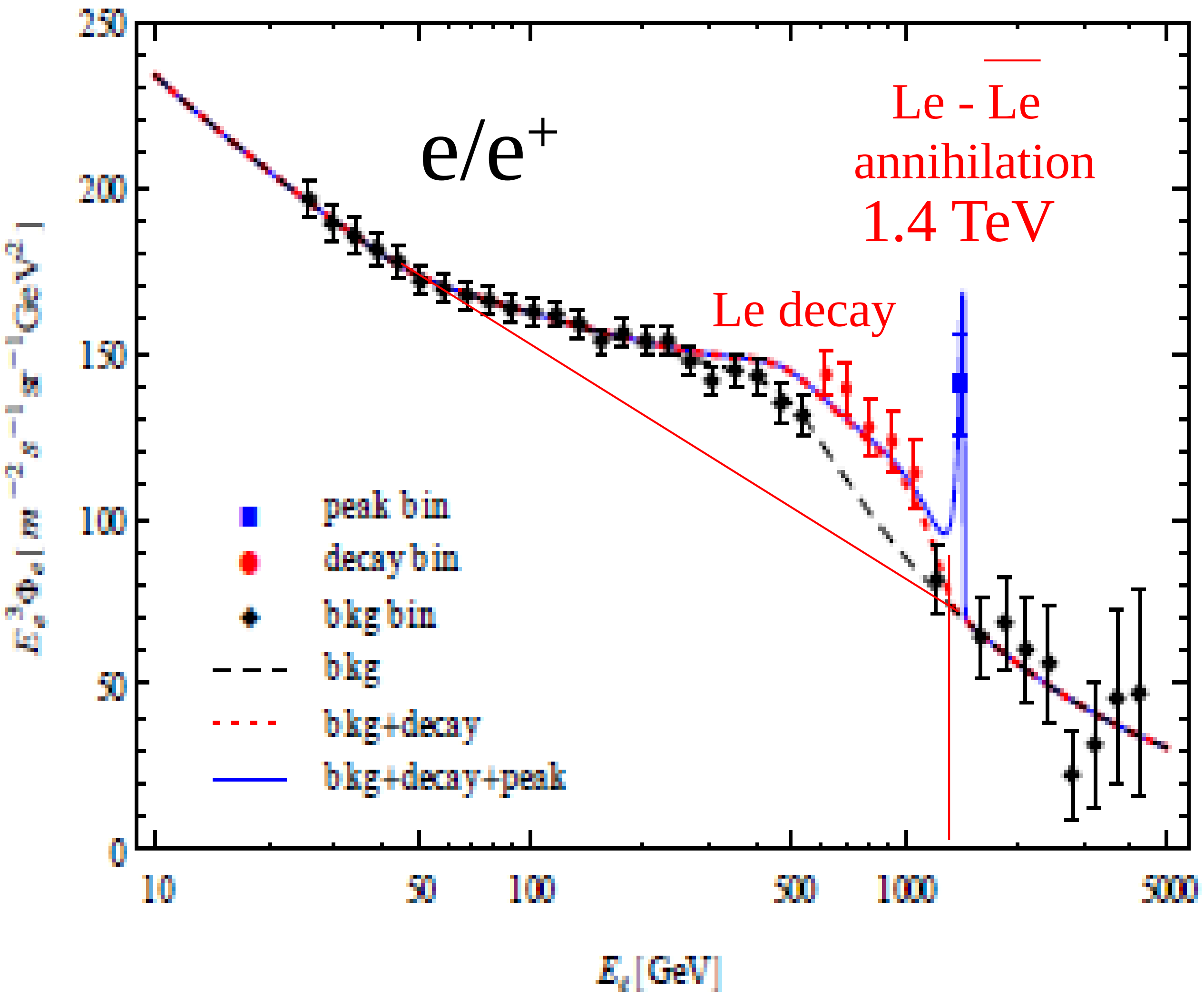
based on m(Le) = 1.4 TeV/c^2.

$E = mc^2$; 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.

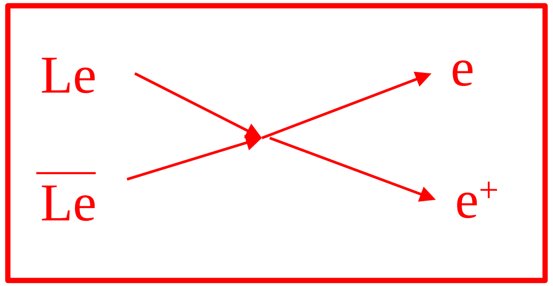


Cosmic ray electron/positron excess origin problem

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

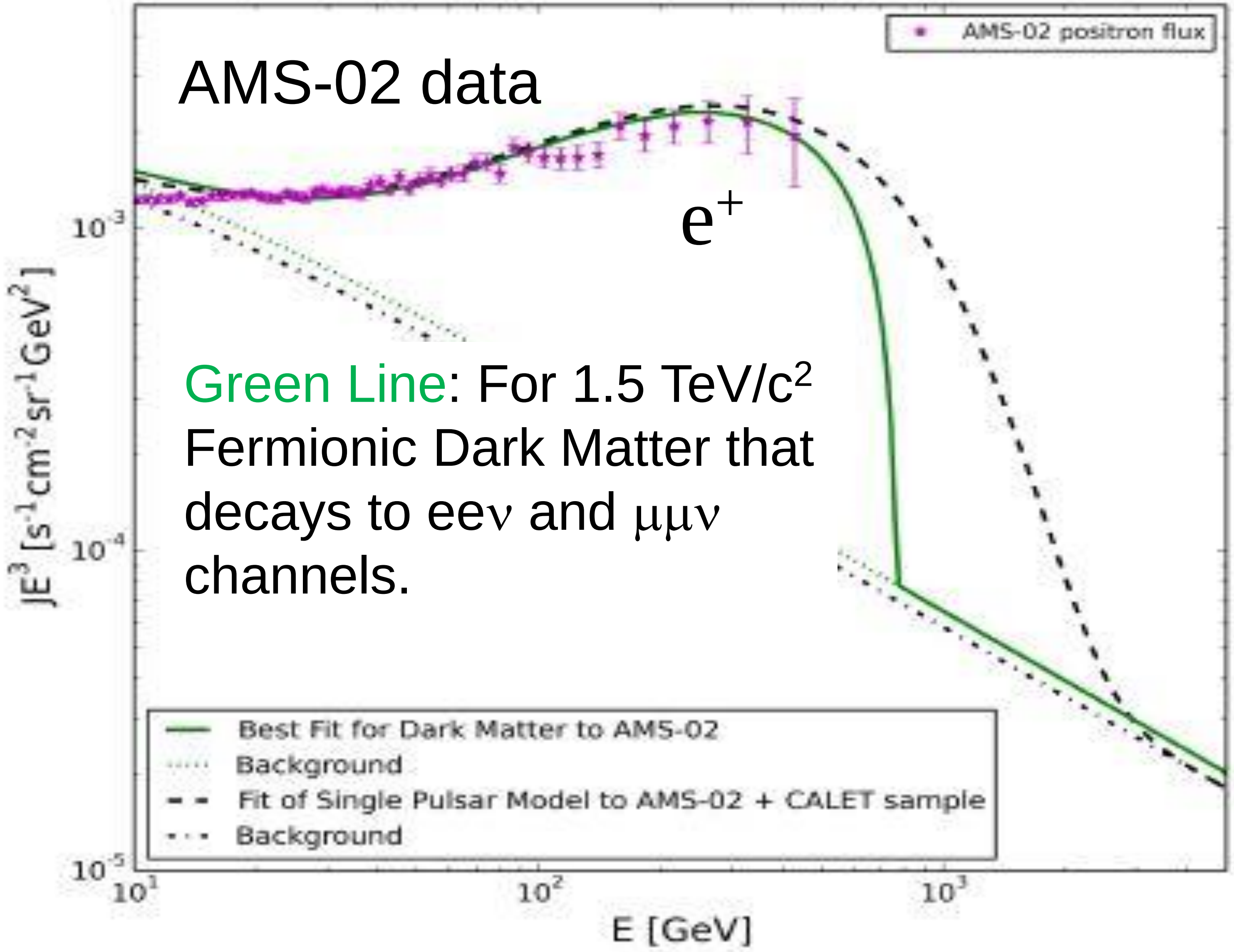
$$\text{Le} \longrightarrow 2\,e + \overline{\nu}_e$$

(-2,-2/3) (-2,-4/3) (0,2/3)



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.



Decaying Fermionic Dark Matter Search with CALETS.
S. Bhattacharyya et al., arXiv: 1712.02744 (2017).

Cosmic ray positron origin problem

1.5 TeV/c^2 dark matter (X)

$X \rightarrow ee\nu$

$X \rightarrow \mu\mu\nu$

1.4 TeV/c^2 Le particle

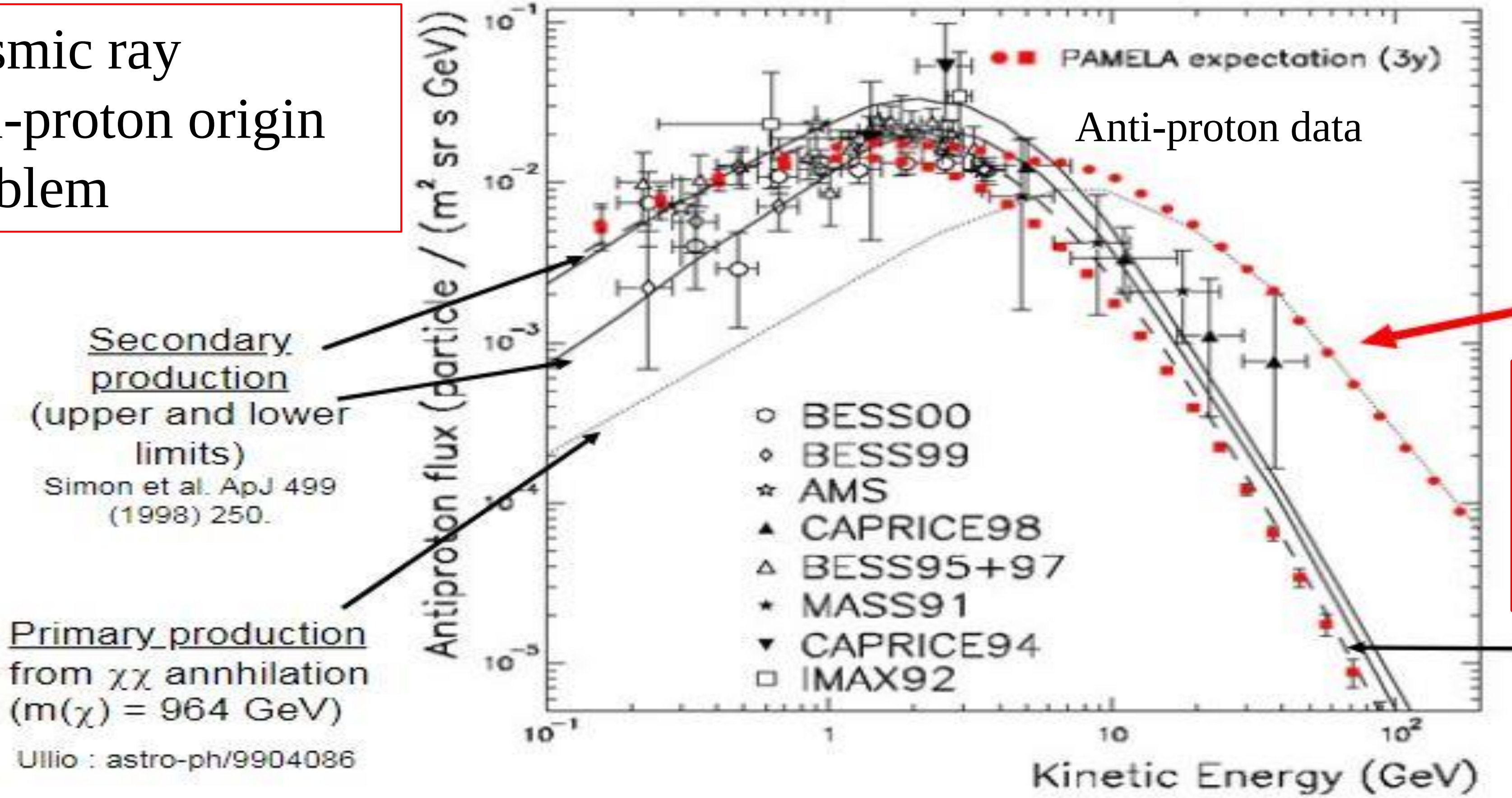
$\overline{Le} \rightarrow 2e^+ + \nu_e$

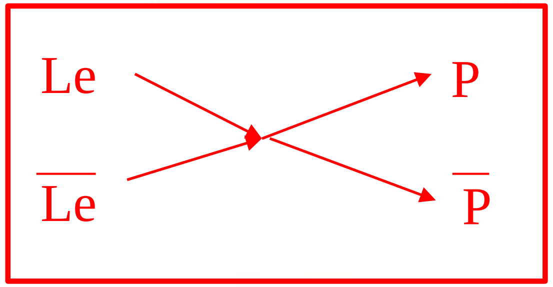
$\overline{Le} \rightarrow 2\mu^+ + \nu_\tau$

$\overline{Le} \rightarrow 2\,\overline{\tau} + \overline{\nu}_e + 2\,\nu_\tau$

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

Cosmic ray anti-proton origin problem



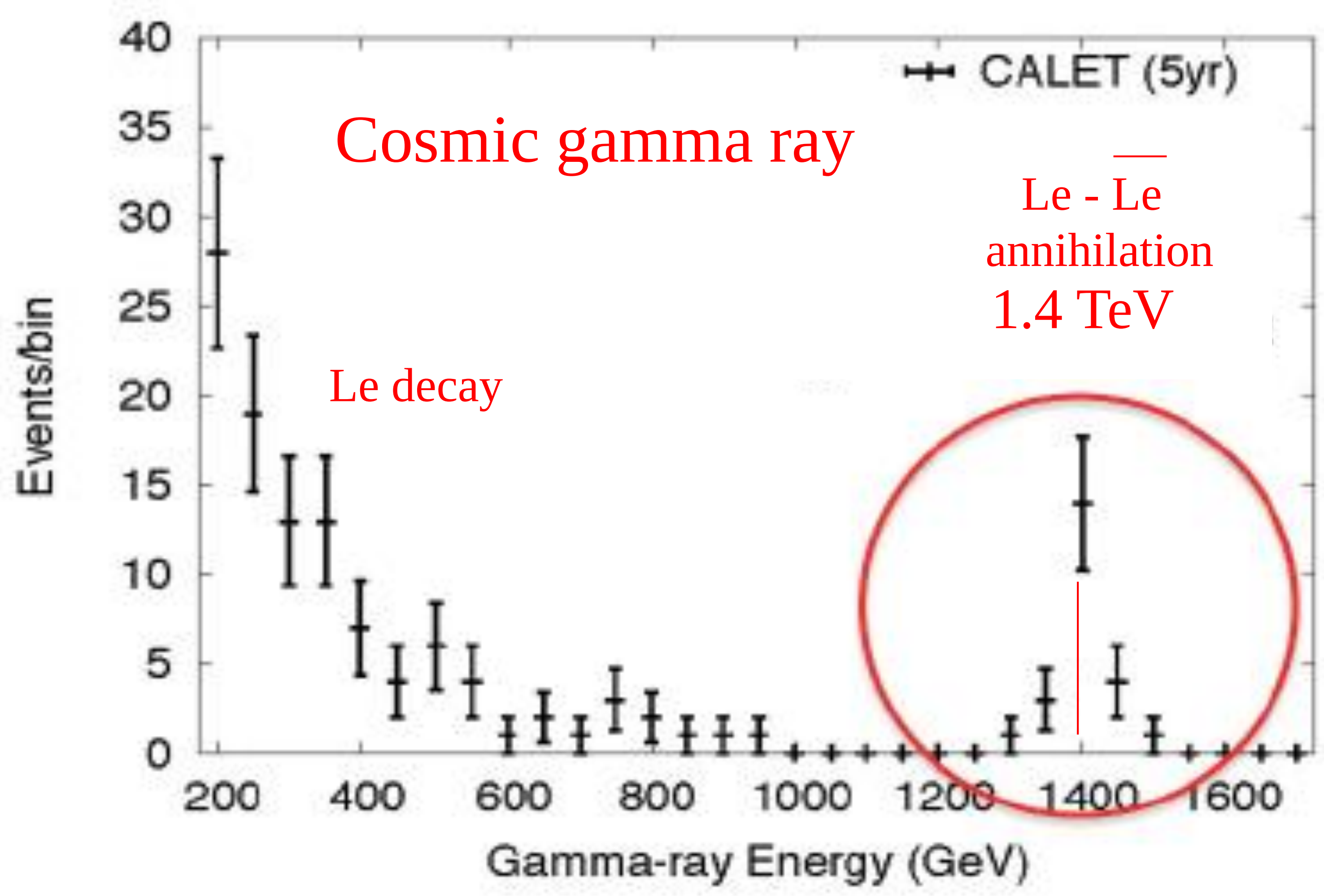


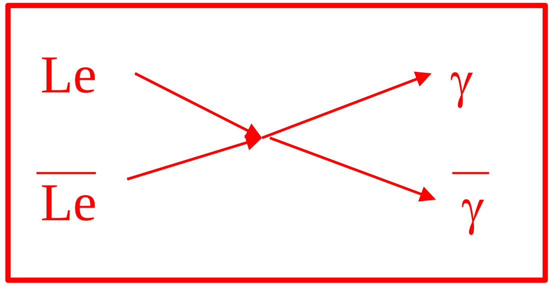
Anti-proton production

964 GeV dark matter annihilation → 1.4 TeV Le particle annihilation (possible)

Mark Pearce (For the PAMELA Collaboration), From talk presentation on PAMELA – a satellite experiment searching for dark matter with cosmic ray antiparticles.

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





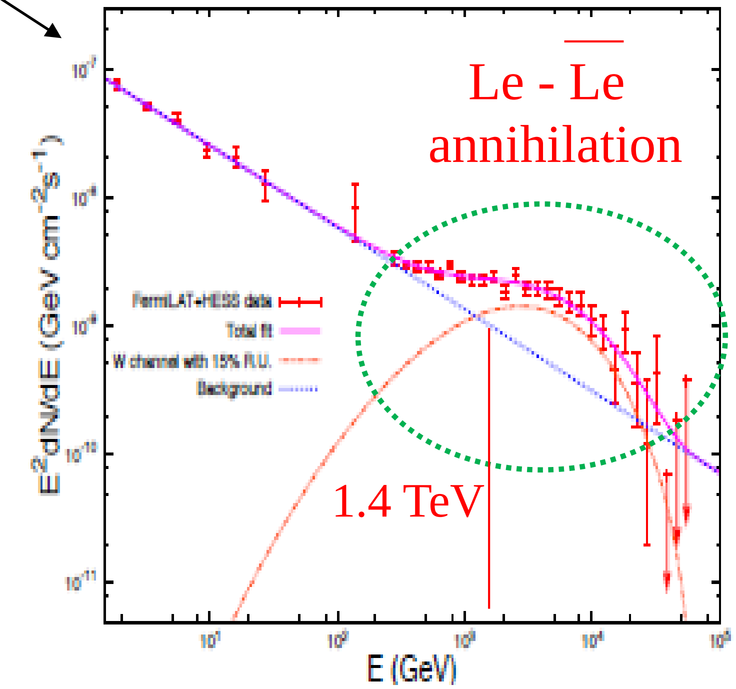
Cosmic gamma ray spectrum by CALET 5 year measurements from the Galactic center including galactic diffusing background

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

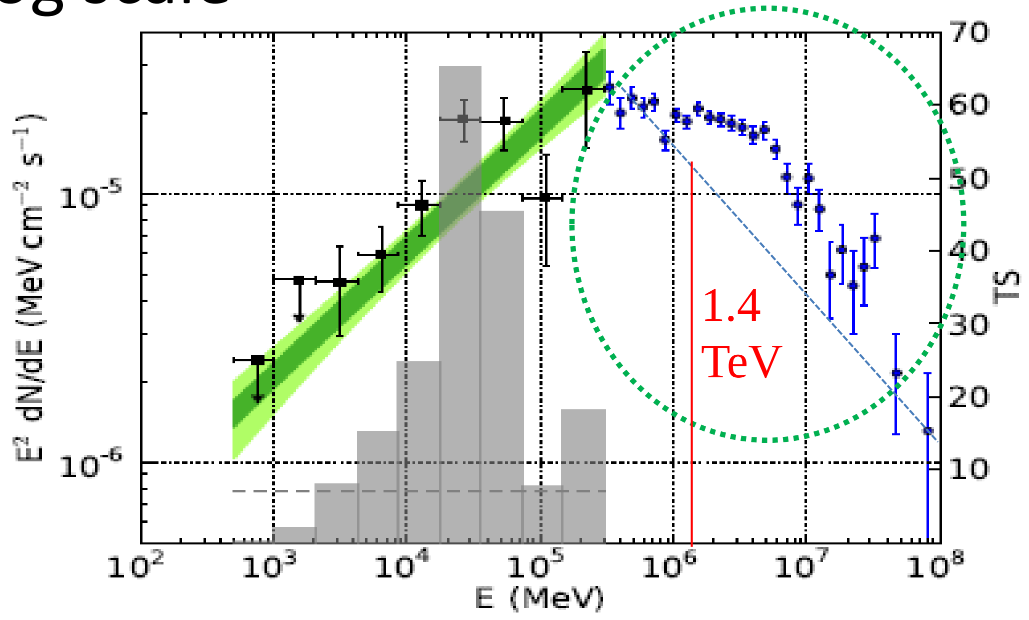
These data support the existence of heavy leptons like Le, Lμ and Lτ.

Le – anti Le annihilation peak.

log scale



log scale



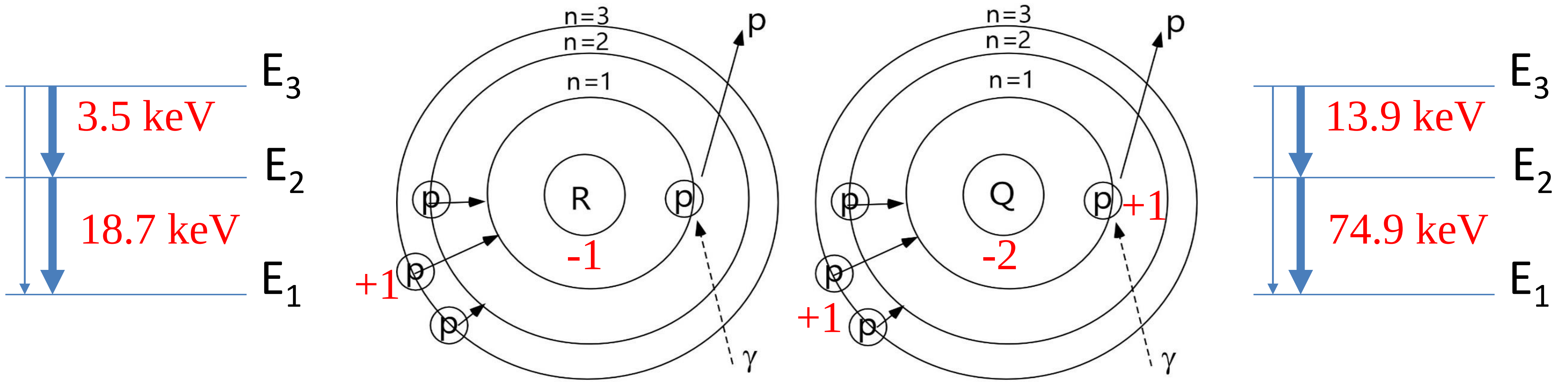
V. Gammaldi, arXiv: 1412.7639 (2014).
TeV gamma ray spectrum from RX J1713.7-3946 with HESS and Fermi-LAT data.

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)

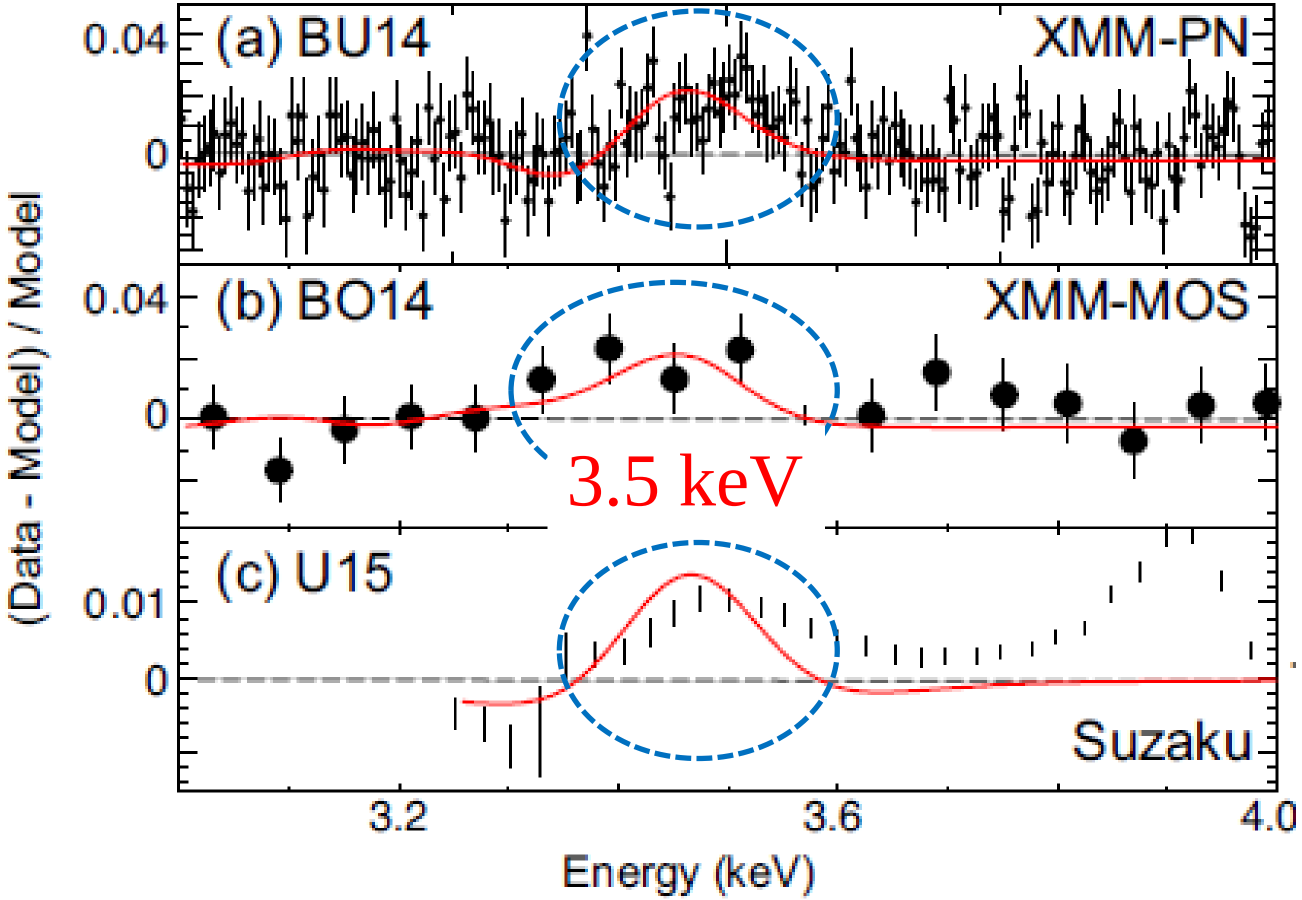
$E_1(x) = E_2 - E_1$
$= 74.9$ keV
$E_2(x) = E_3 - E_2$
$= 13.9$ keV
$E_3(x) = E_3 - E_1$
$= 88.8$ keV

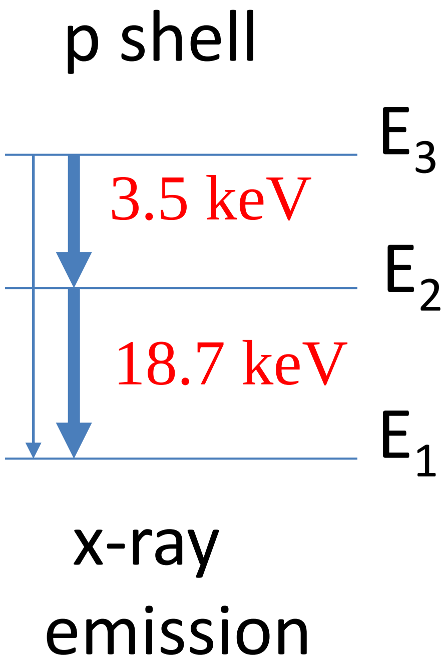
p(u,u,d)(1,0)
Proton

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

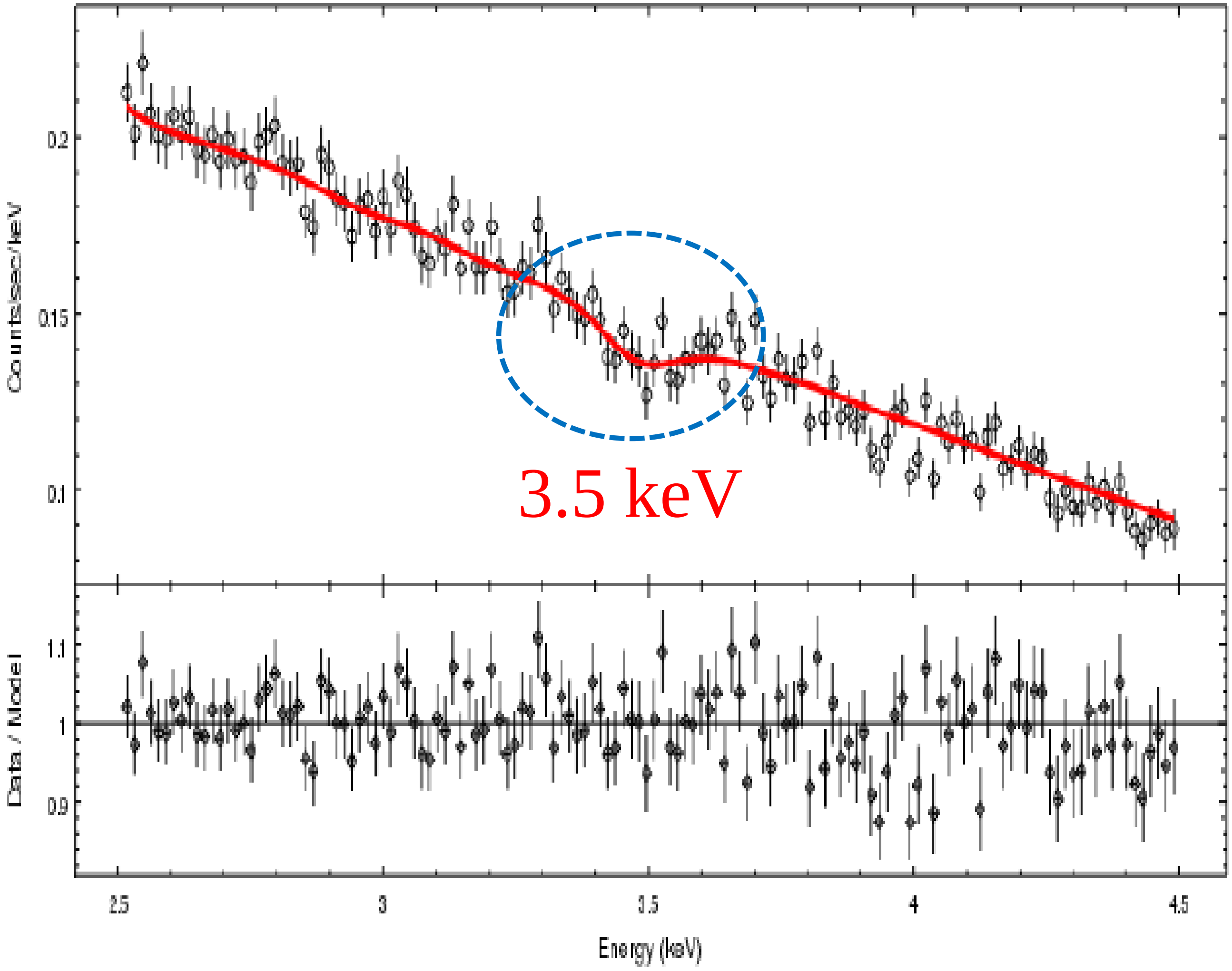


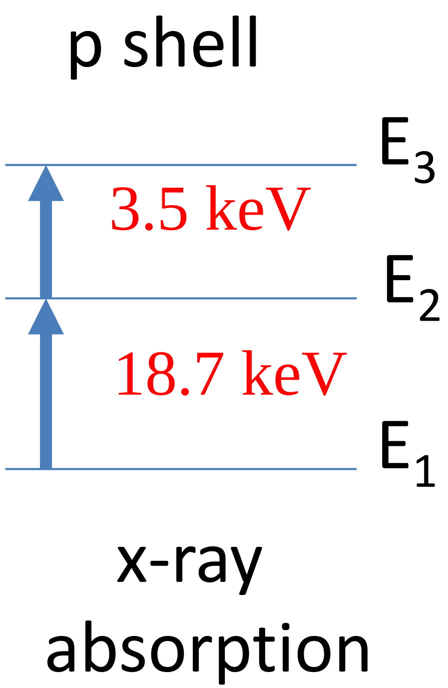


E. Bulbul et al. 2014, ApJ, 789, 13 (BU14). A. Boyarsky et al., 2014, Phys. Rev. Lett., 113, 251301 (BO14).

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

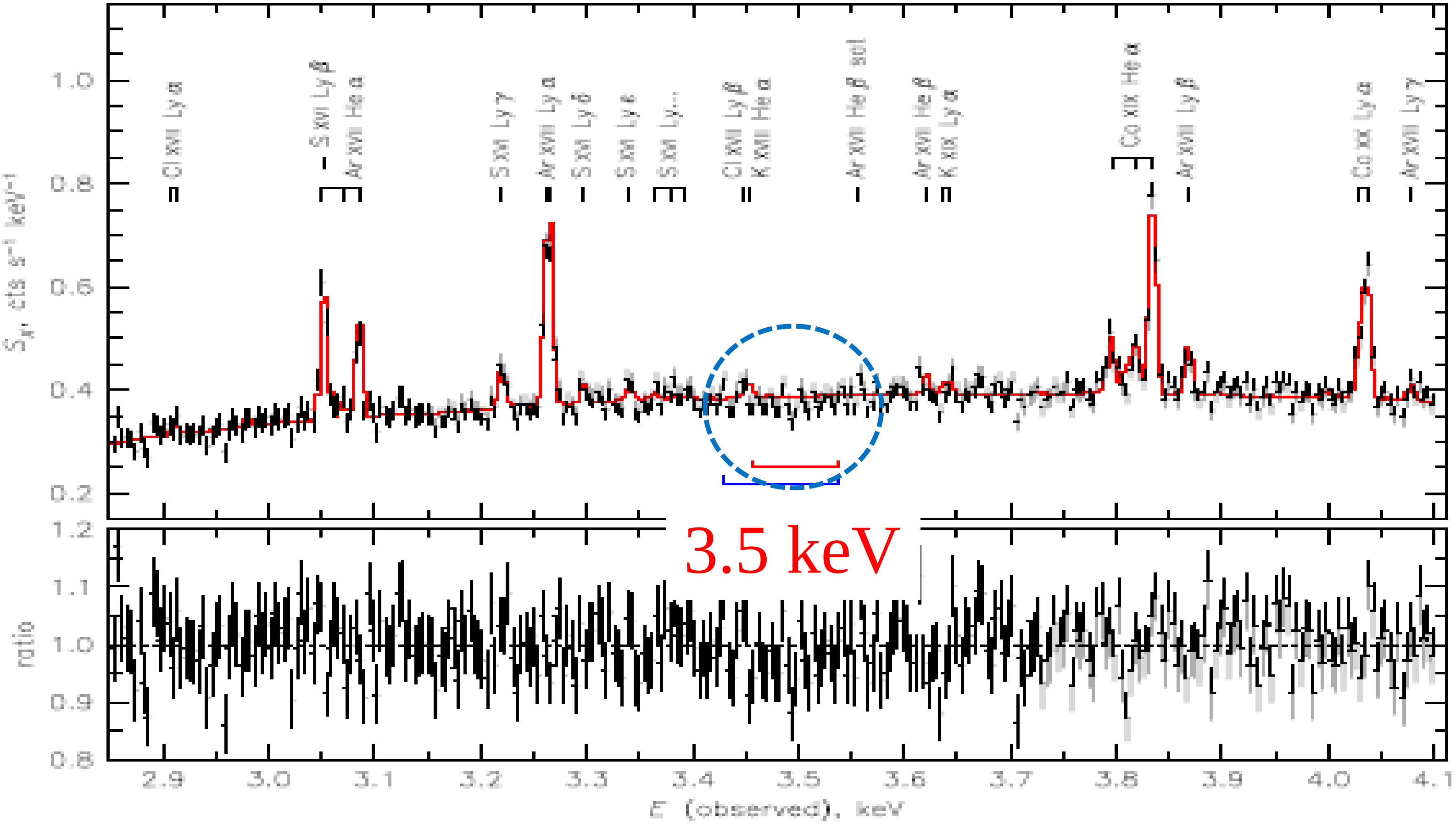




3.5 keV AGN x-ray absorption line from 2009 Chandra data for Perseus cluster

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

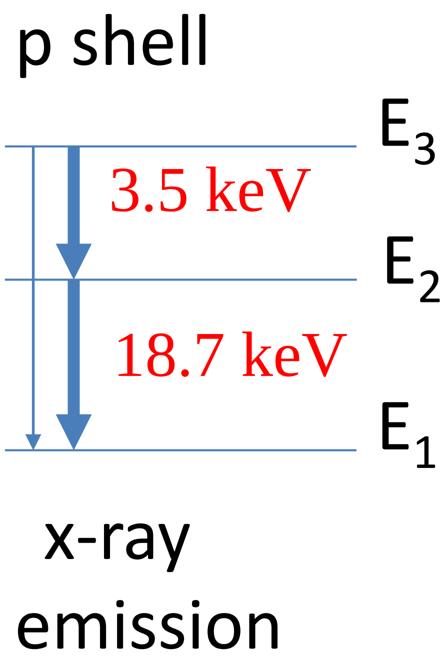
diffuse cluster x-ray emission and the point-like central Active Galactic Nucleus (AGN) x-ray absorption



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

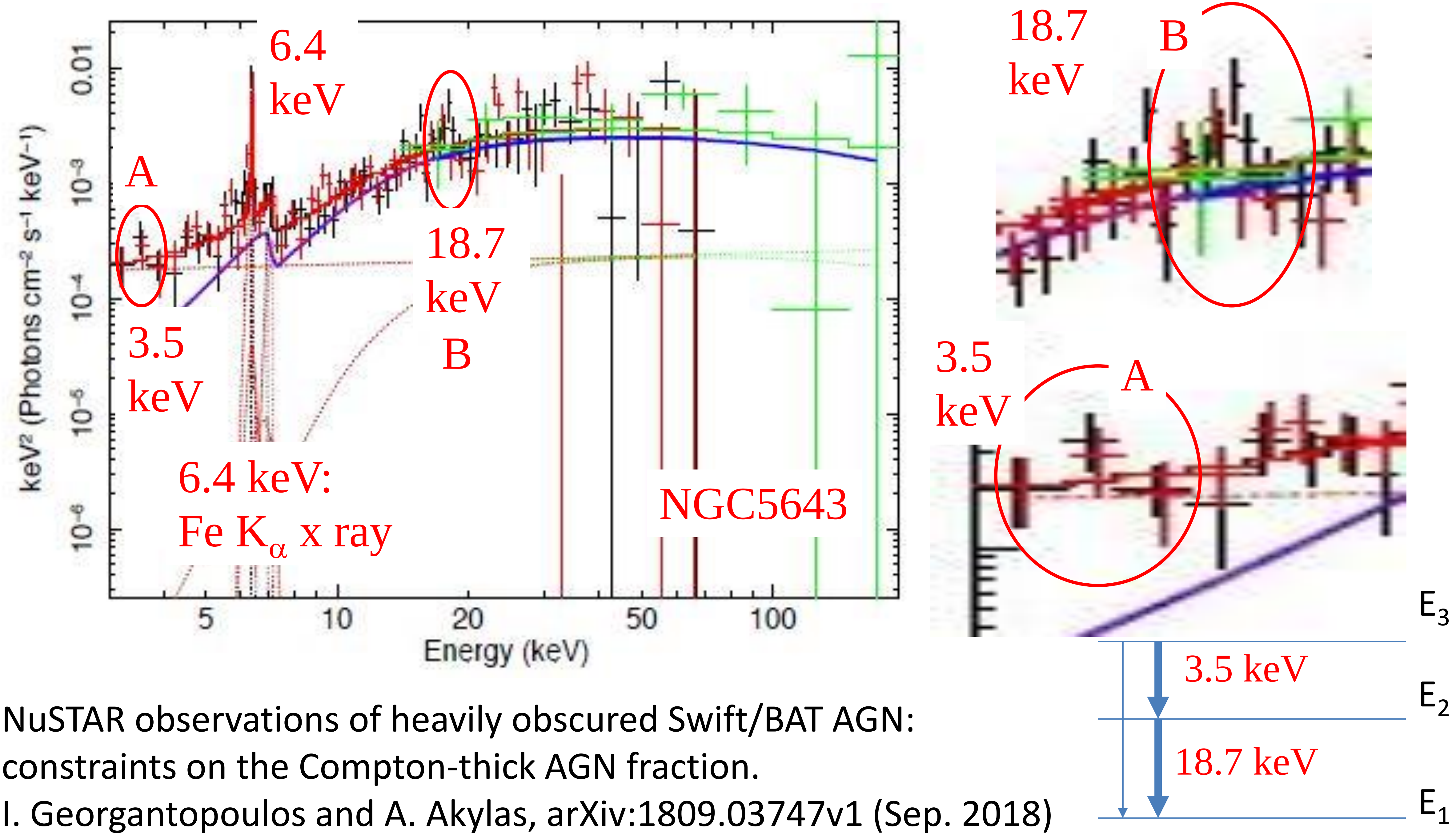
F.A. Aharonianet al. arXiv: 1607.007420v2 (2017).

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?

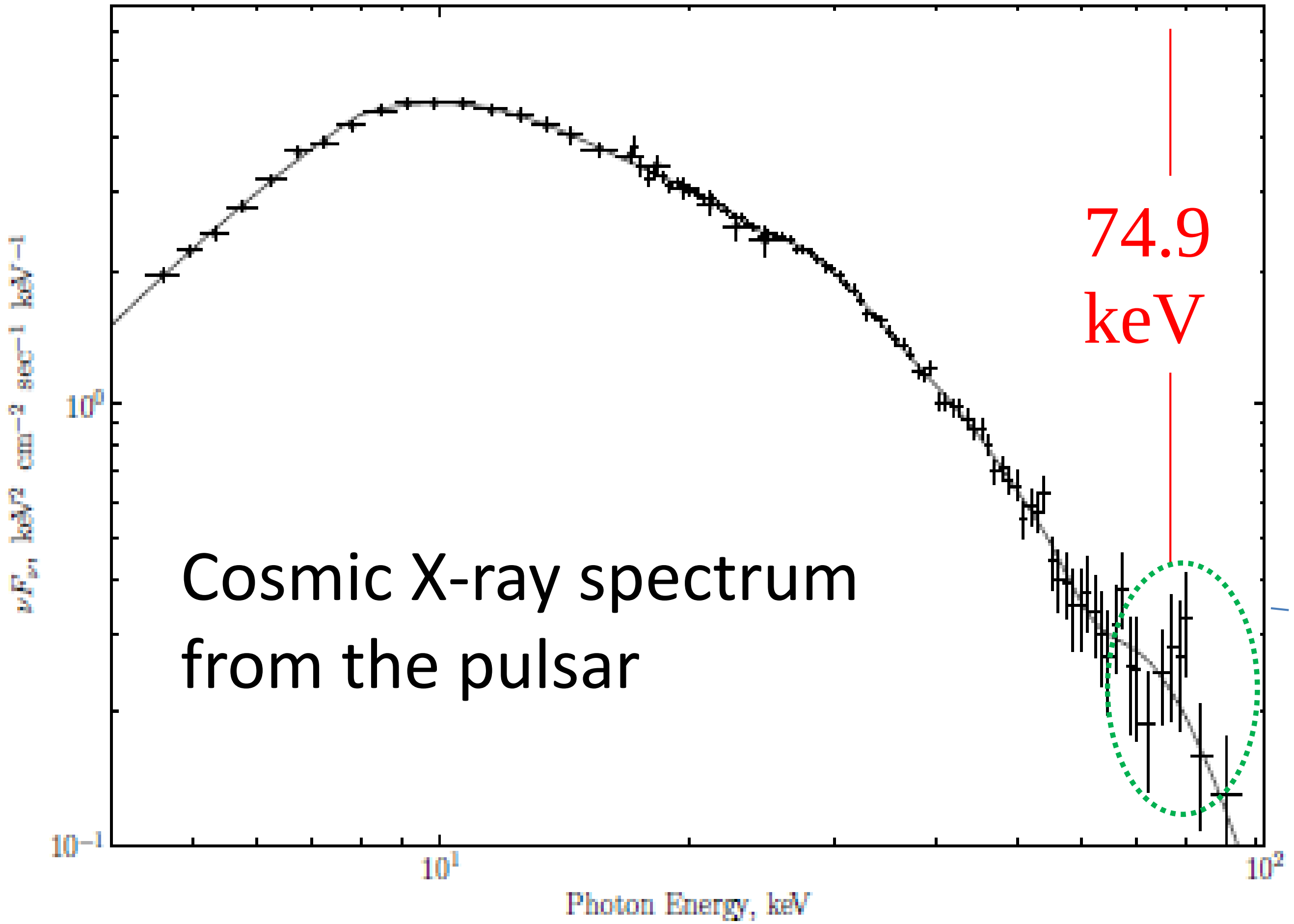


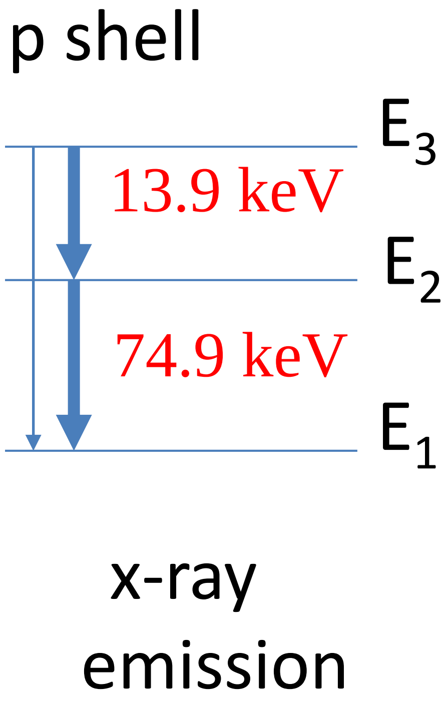
~18.7 (?): The better statistics could make the better peak shape

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



NuSTAR observations of heavily obscured Swift/BAT AGN: constraints on the Compton-thick AGN fraction.
I. Georgantopoulos and A. Akylas, arXiv:1809.03747v1 (Sep. 2018)





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.

Origin problem of the ultra high energy cosmic rays

Q1 baryon (Q,R baryons) decays (present work)

$N(Q1,u,u)(0,0,-5) \longrightarrow p + e + \bar{\nu}_e$ (Favored)

$R(Q1,d,u)(-1,0,-5) \longrightarrow p + 2e + 2\bar{\nu}_e$ (Favored)

$pR \longrightarrow pp + 2e + 2\bar{\nu}_e \longrightarrow {}^2He + 2\bar{\nu}_e$

$pR \longrightarrow pn + e + \bar{\nu}_e \longrightarrow d + \bar{\nu}_e$

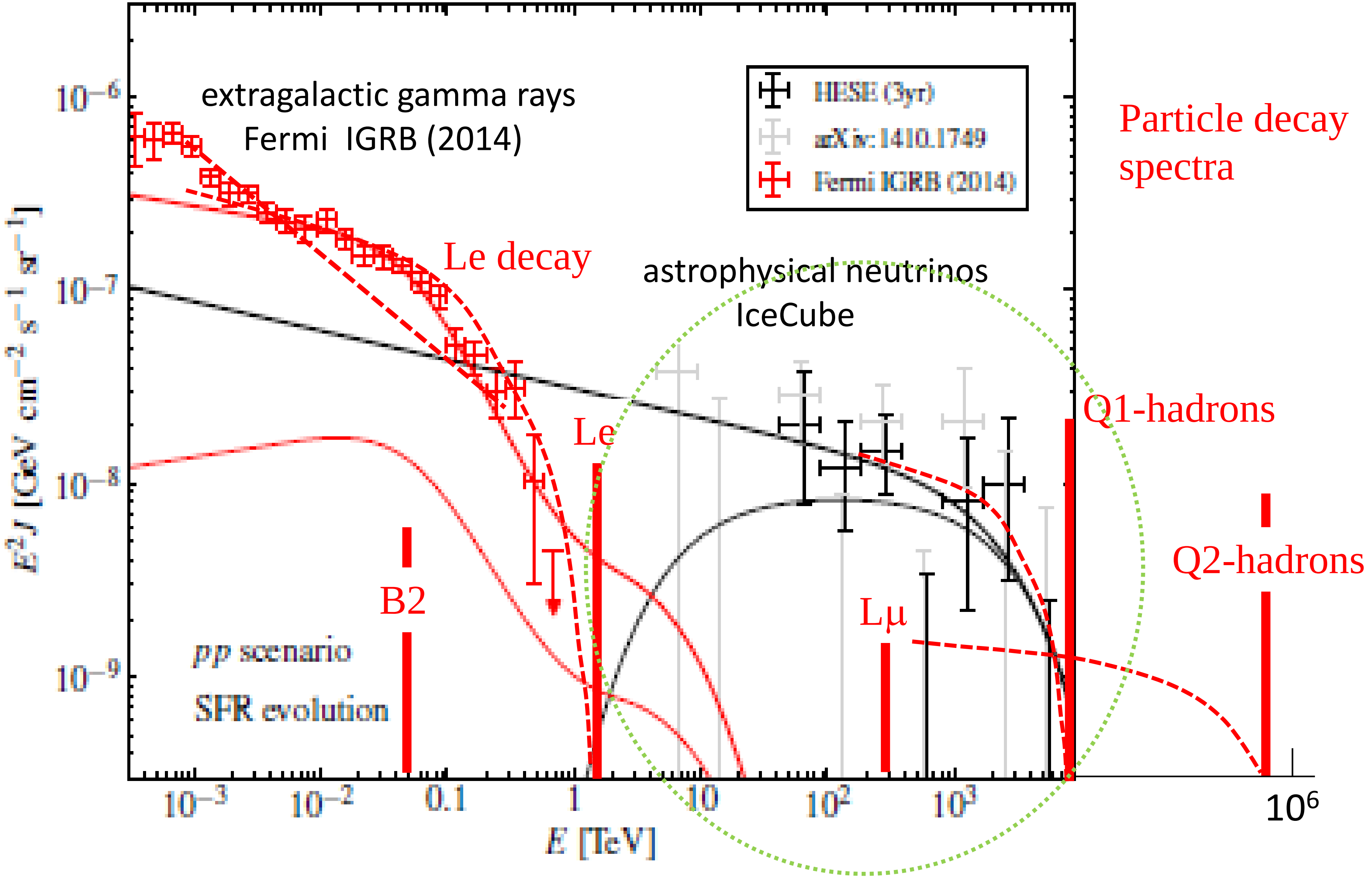
$ppQ \longrightarrow ppn + 2e + 2\bar{\nu}_e \longrightarrow {}^3He + 2\bar{\nu}_e$ (Favored)

$ppRR \longrightarrow ppnn + 2e + 2\bar{\nu}_e \longrightarrow {}^4He + 2\bar{\nu}_e$

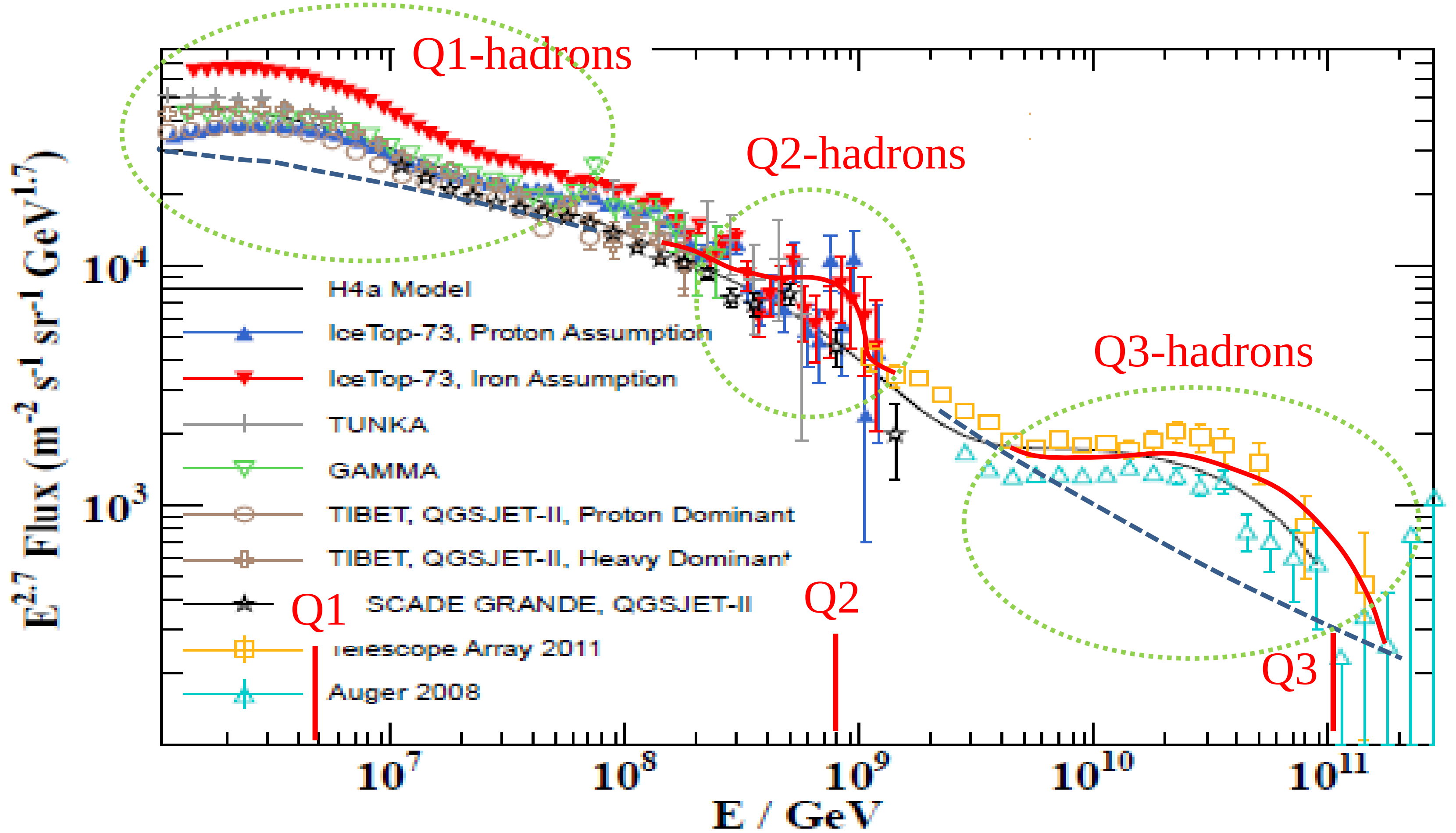
The ultra high energy cosmic rays are originated from the Q1, Q2 and Q3 hadron decays. The rest mass energies are proposed as $E(Q1) = 5\ 10^{15}$ eV, $E(Q2) = 7\ 10^{17}$ eV and $E(Q3) = 10^{20}$ eV.

This supports the existence of the new heavy Q1, Q2 and Q3 quarks

Ultra high energy neutrino measurements



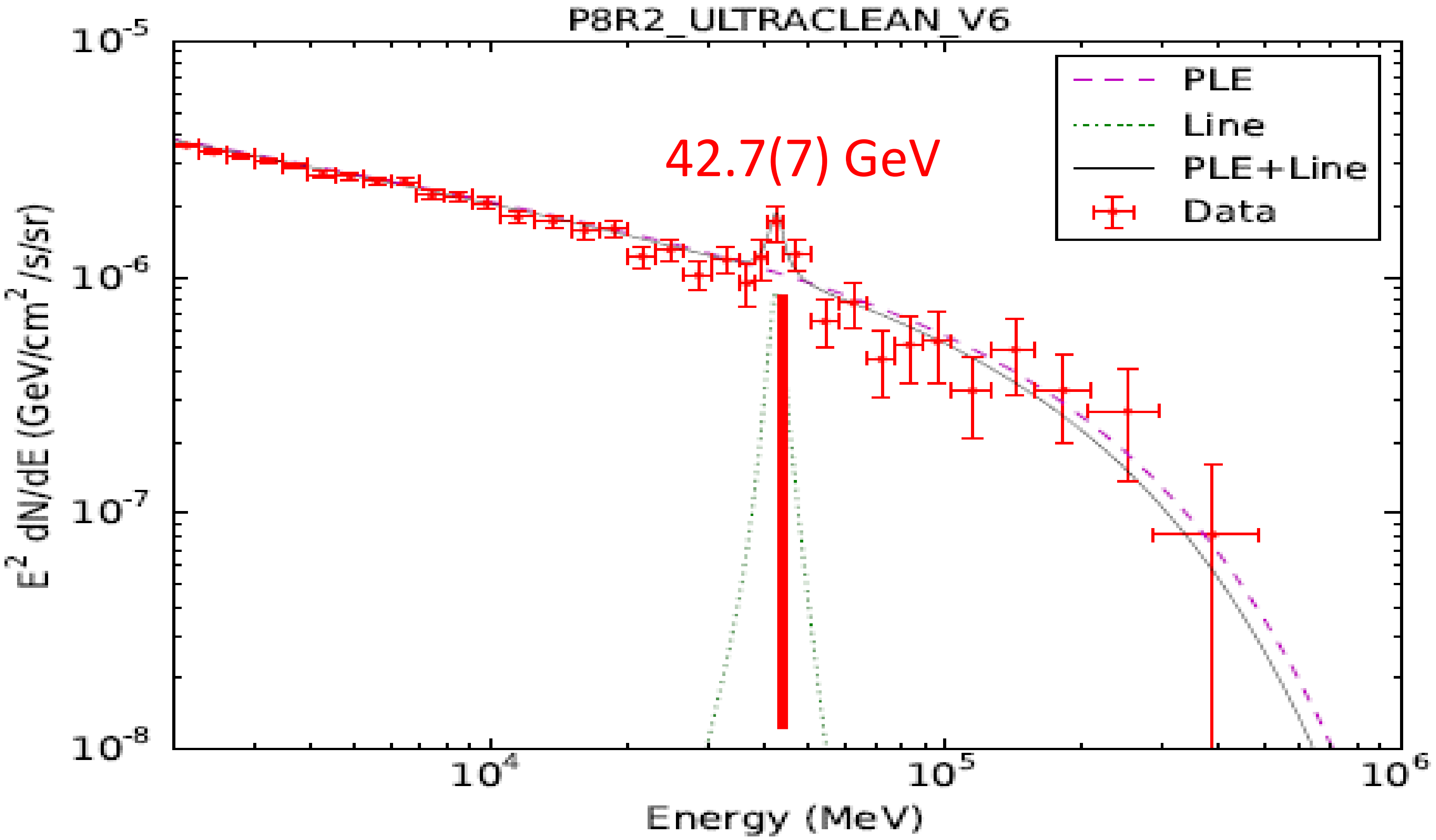
M.G. Aartsen et al., arXiv: 1412.5106 (2014)
IceCube-Gen2: A Vision for the Future of Neutrino Astronomy in Antarctica



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.

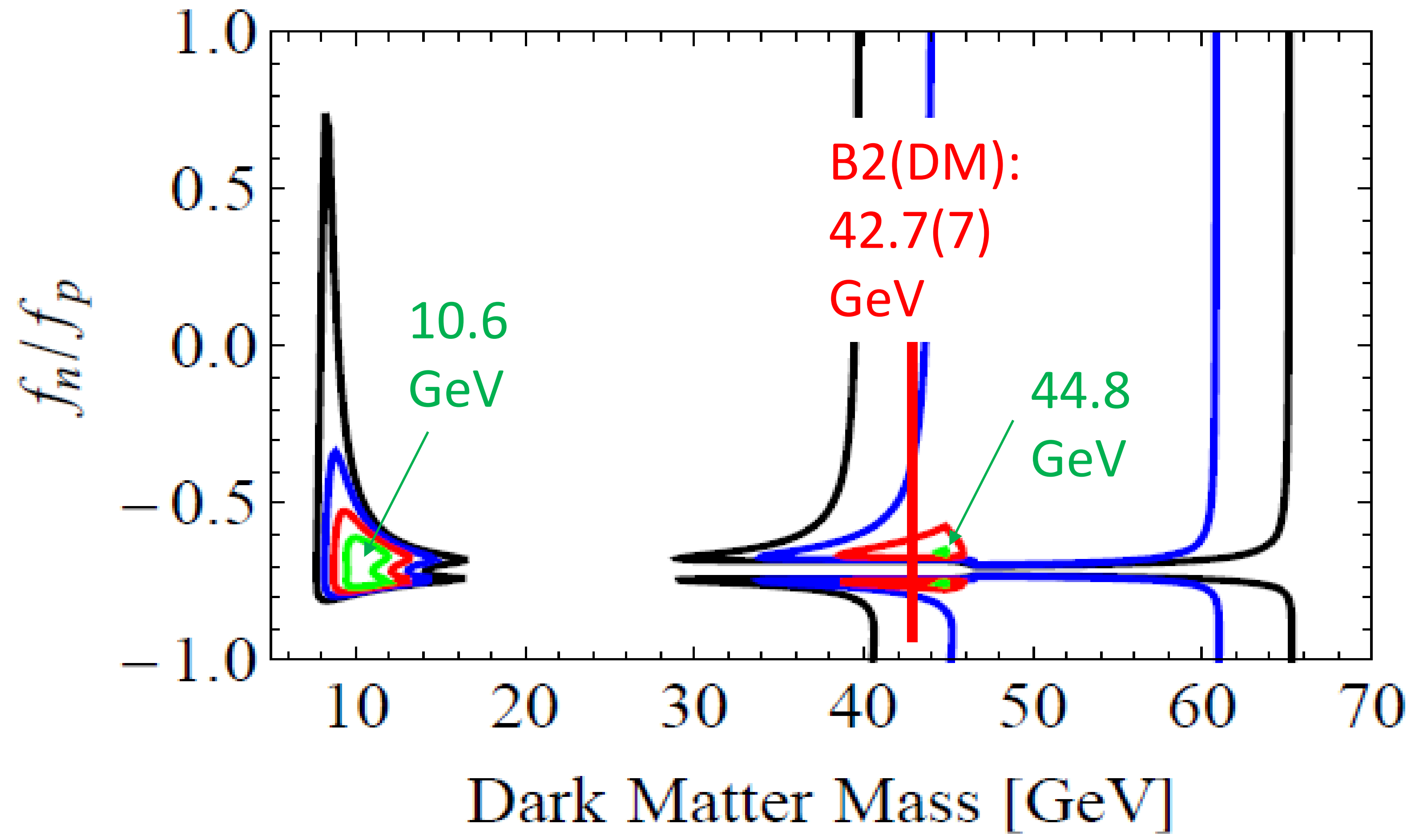
B2 fermionic dark matter measurements



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).

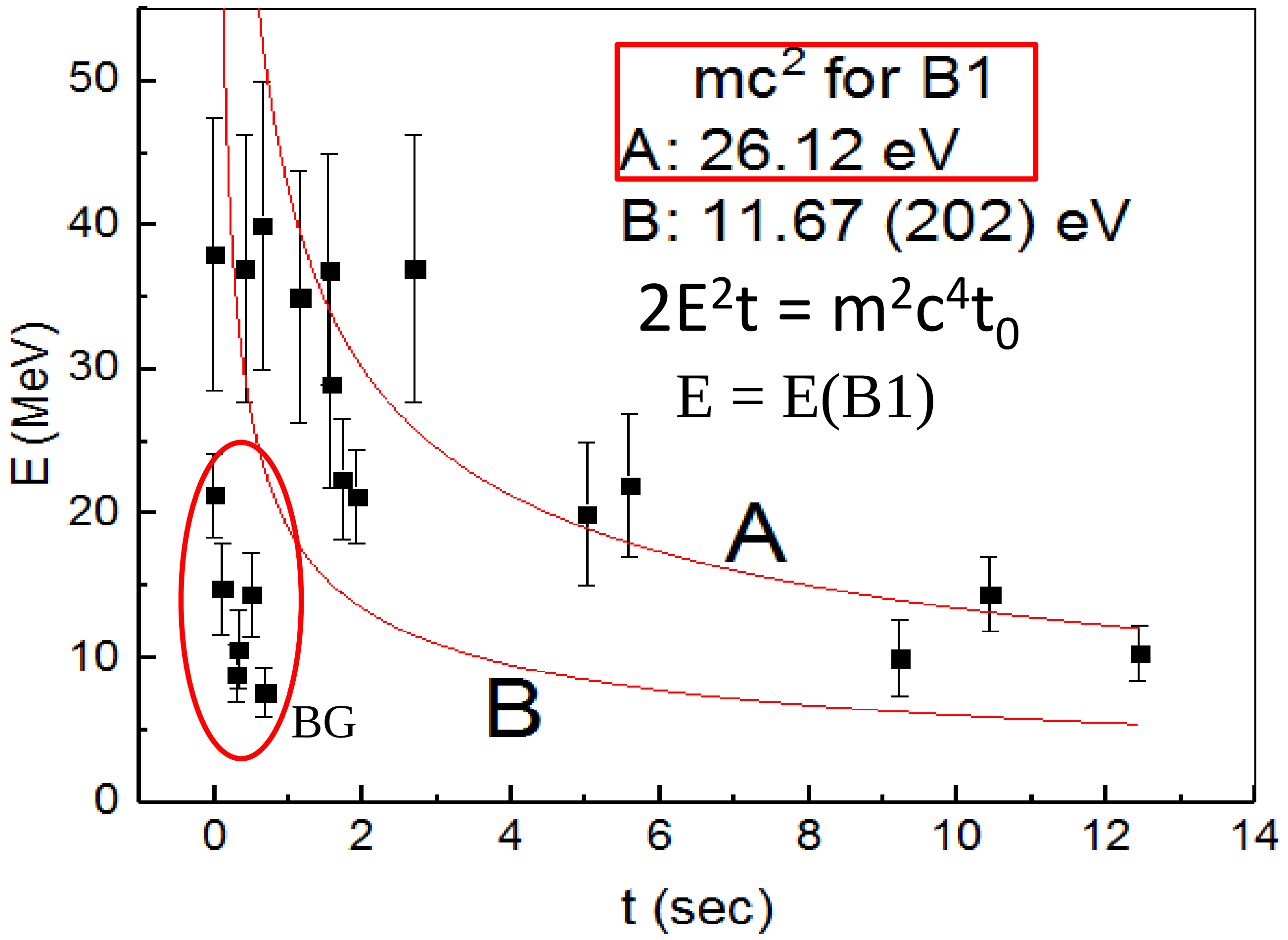
The 42.7 GeV peak is proposed as the B2 annihilation peak.



Dark matter rest mass energy was reported around the energy 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

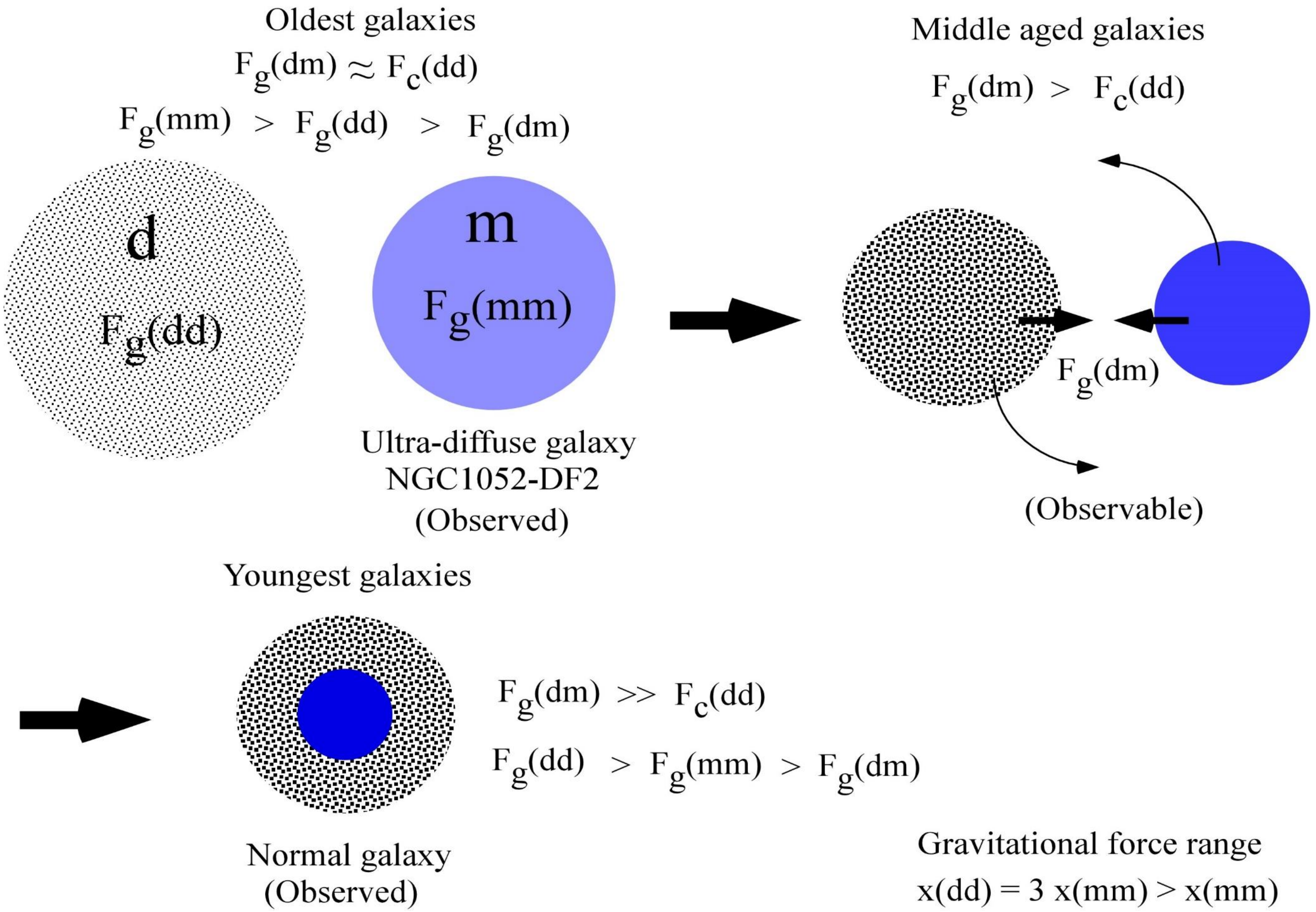
Kamiokande-II + IMB

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.

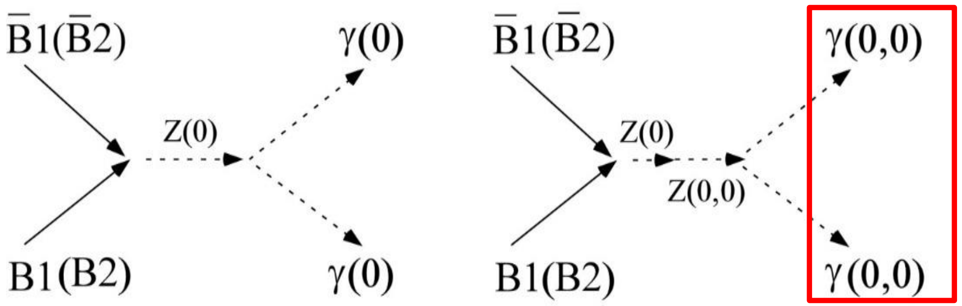
R. Ehrlich, Astropart. Phys. 35, 625 (2012).



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

particle - anti particle annihilations

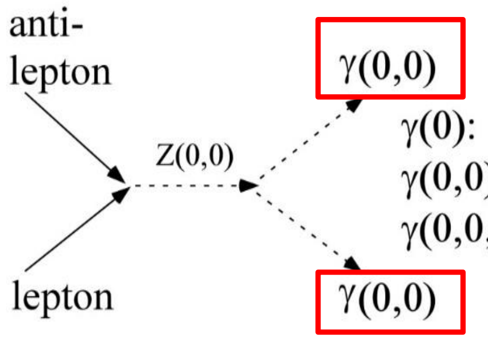
I(γ(0)) >> I(γ(0,0))
(Dark matters)



Observable
(weak)

Difficult but possible to be observed at LHC

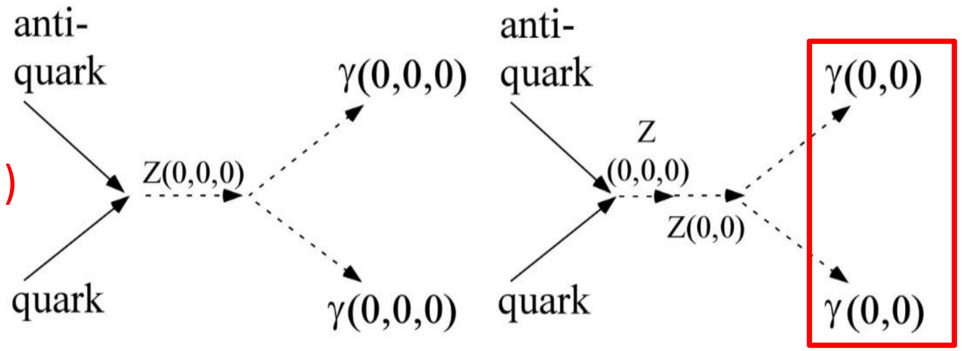
I(γ(0,0)) >> I(γ(0))
(Leptons,Hadrons)



Based on the x1x2x3 universe
γ(0): baston photon (dark photon)
γ(0,0): lepton photon (normal photon)
γ(0,0,0): quark photon (unobservable photon)

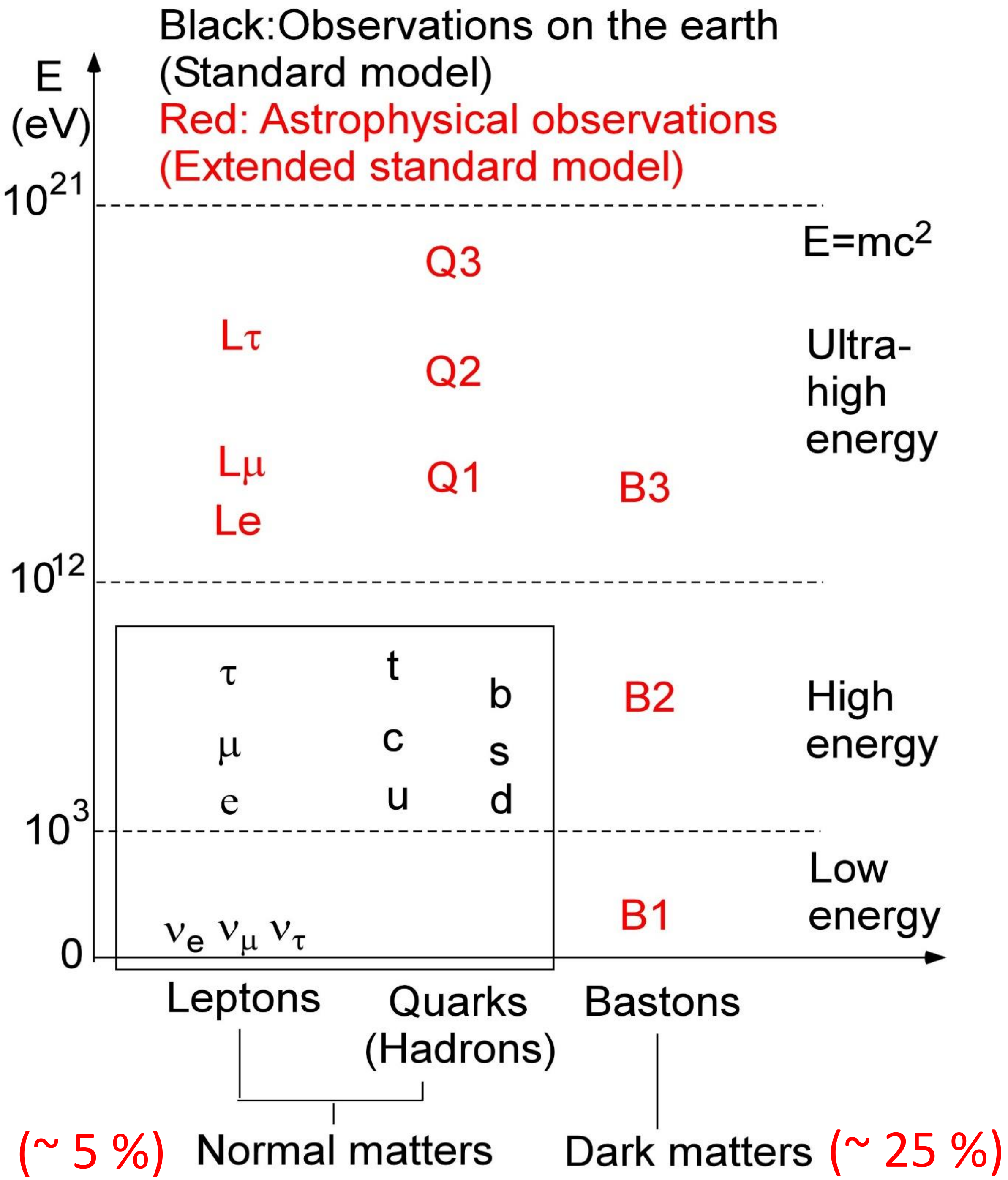
γ(0,0):
Observable
(strong)

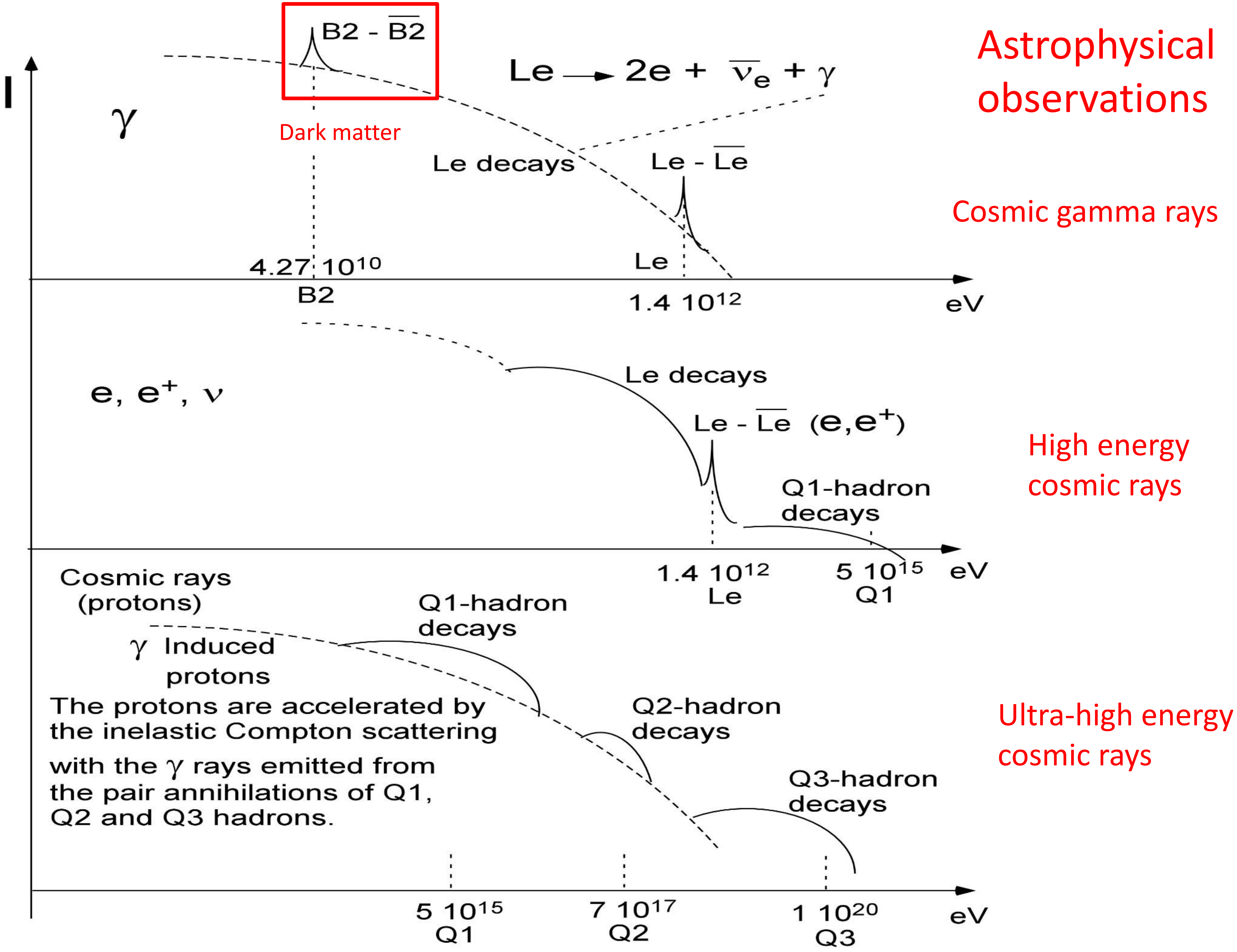
I(γ(0,0,0)) >> I(γ(0,0))
(Quarks)



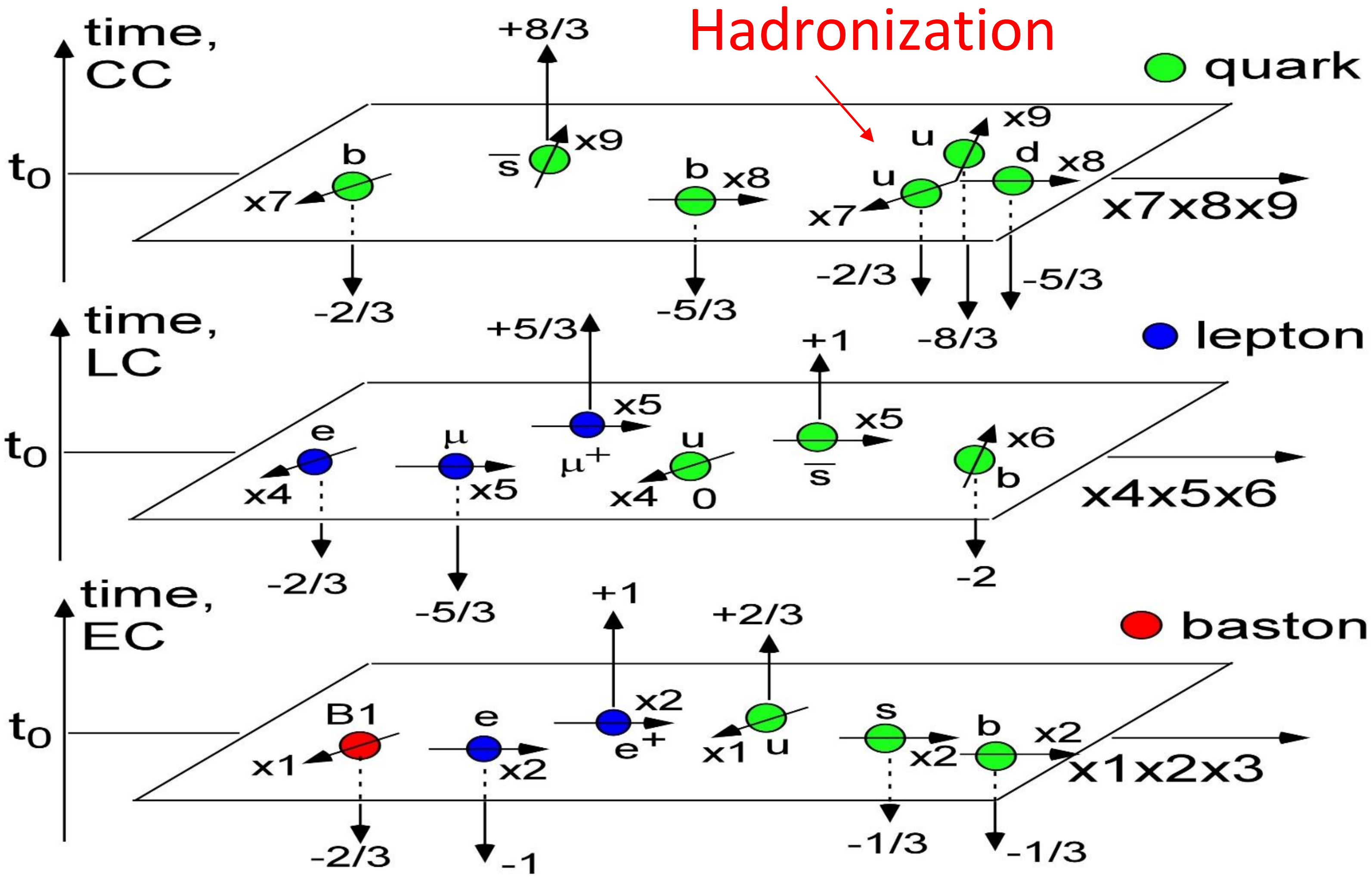
Observable
(weak)

Z(0)⟷ Z(0,0)⟷ Z(0,0,0): Force carrying bosons
γ(0)⟷X⟷ γ(0,0)⟷X⟷ γ(0,0,0): Charge dependent photons
g(0)⟷ g(0,0)⟷ g(0,0,0): gravitons


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



Astrophysical observations
I
γ
B2 - $\overline{B2}$
Dark matter
$Le \rightarrow 2e + \overline{\nu}_e + \gamma$
Le decays
Le - $\overline{Le}$
Le
4.27 10^{10}
B2
1.4 10^{12}
eV
Cosmic gamma rays
e, e^+, ν
Le decays
Le - $\overline{Le}$ (e,e^+)
Q1-hadron decays
1.4 10^{12}
Le
5 10^{15}
Q1
eV
High energy cosmic rays
Cosmic rays (protons)
Q1-hadron decays
γ Induced protons
The protons are accelerated by the inelastic Compton scattering with the γ rays emitted from the pair annihilations of Q1, Q2 and Q3 hadrons.
Q2-hadron decays
Q3-hadron decays
5 10^{15}
Q1
7 10^{17}
Q2
1 10^{20}
Q3
eV
Ultra-high energy cosmic rays



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.

Coulomb's constant

k(mm) = k >> k(dd) > 0

k(mm): $\gamma(0,0)$

k(dd): $\gamma(0)$ dark photon

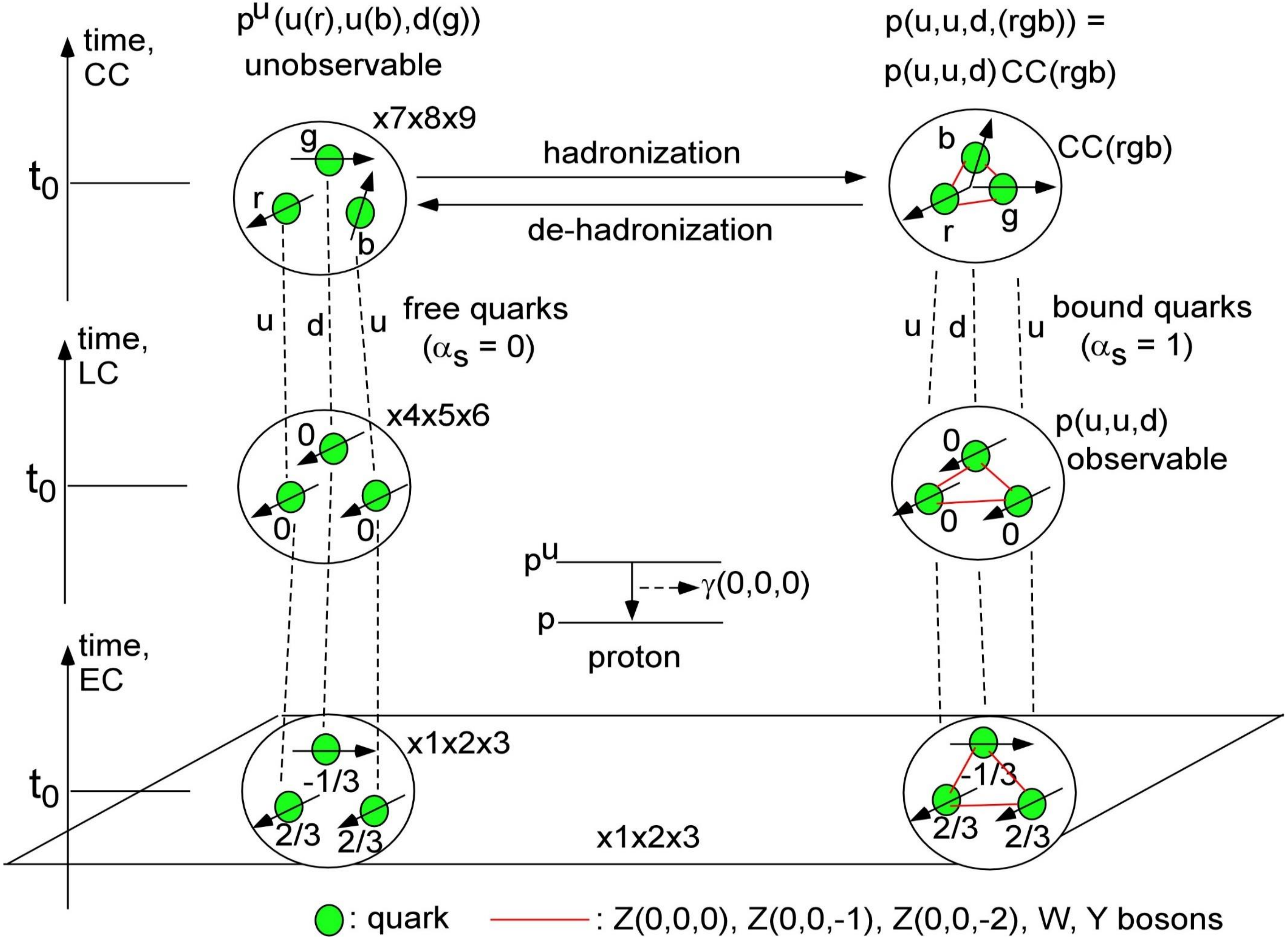
Charged dark matters

$F_g(dd) >> F_c(dd) > 0$

at the present time

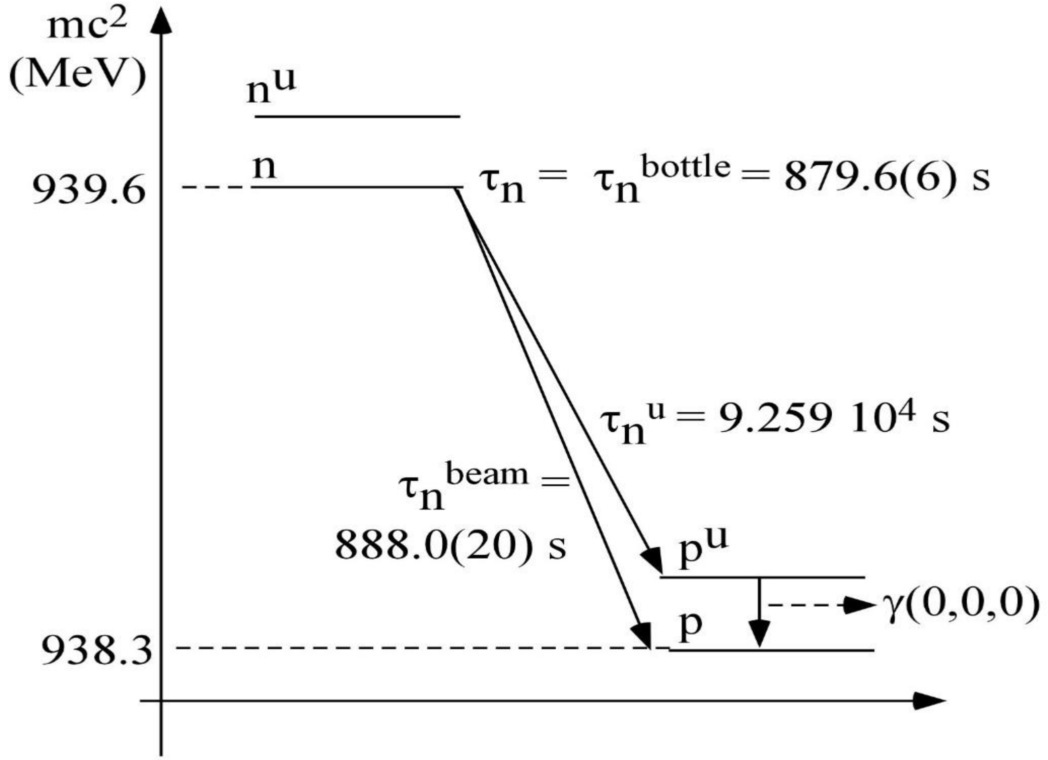
$F_g(dd)$: Attractive force

$F_c(dd)$: Repulsive force



time, CC
time, LC
time, EC
t0
t0
t0
pu(u(r),u(b),d(g))
unobservable
x7x8x9
g
r
b
hadronization
de-hadronization
p(u,u,d,(rgb)) =
p(u,u,d) CC(rgb)
CC(rgb)
b
r
g
u
d
u
free quarks
(αs = 0)
u
d
u
bound quarks
(αs = 1)
x4x5x6
0
0
0
p(u,u,d)
observable
0
0
0
pu
γ(0,0,0)
p
proton
x1x2x3
-1/3
2/3
2/3
-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

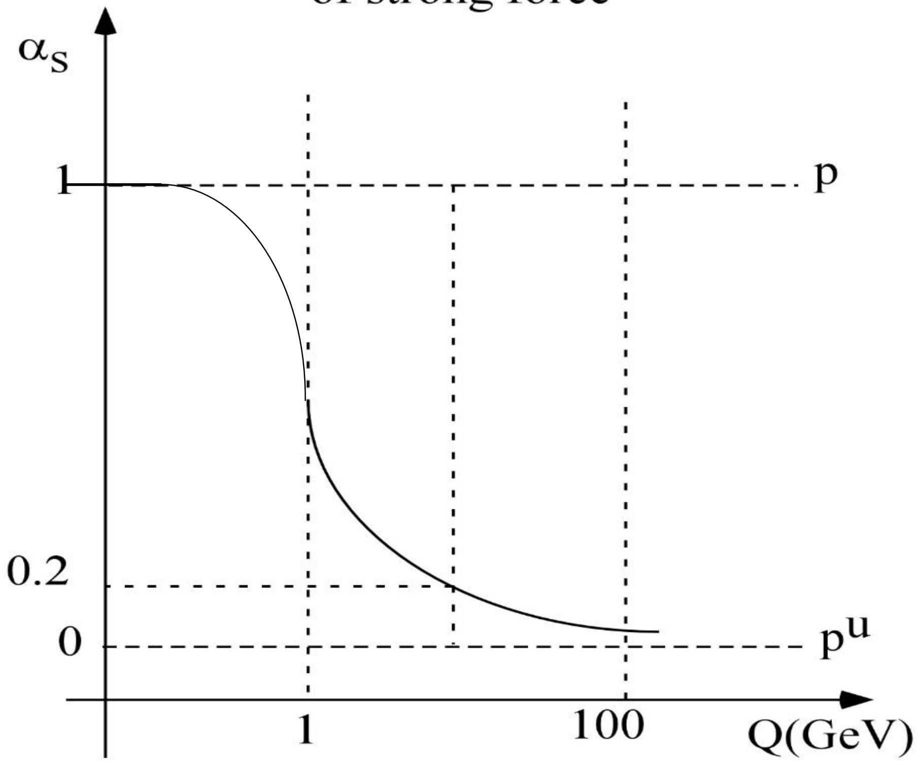


$$n \rightarrow p + e + \overline{\nu}_e \quad 99.05\ \%$$
$$n \rightarrow p^u + e + \overline{\nu}_e \quad 0.95\ \%$$

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.

coupling constant of strong force

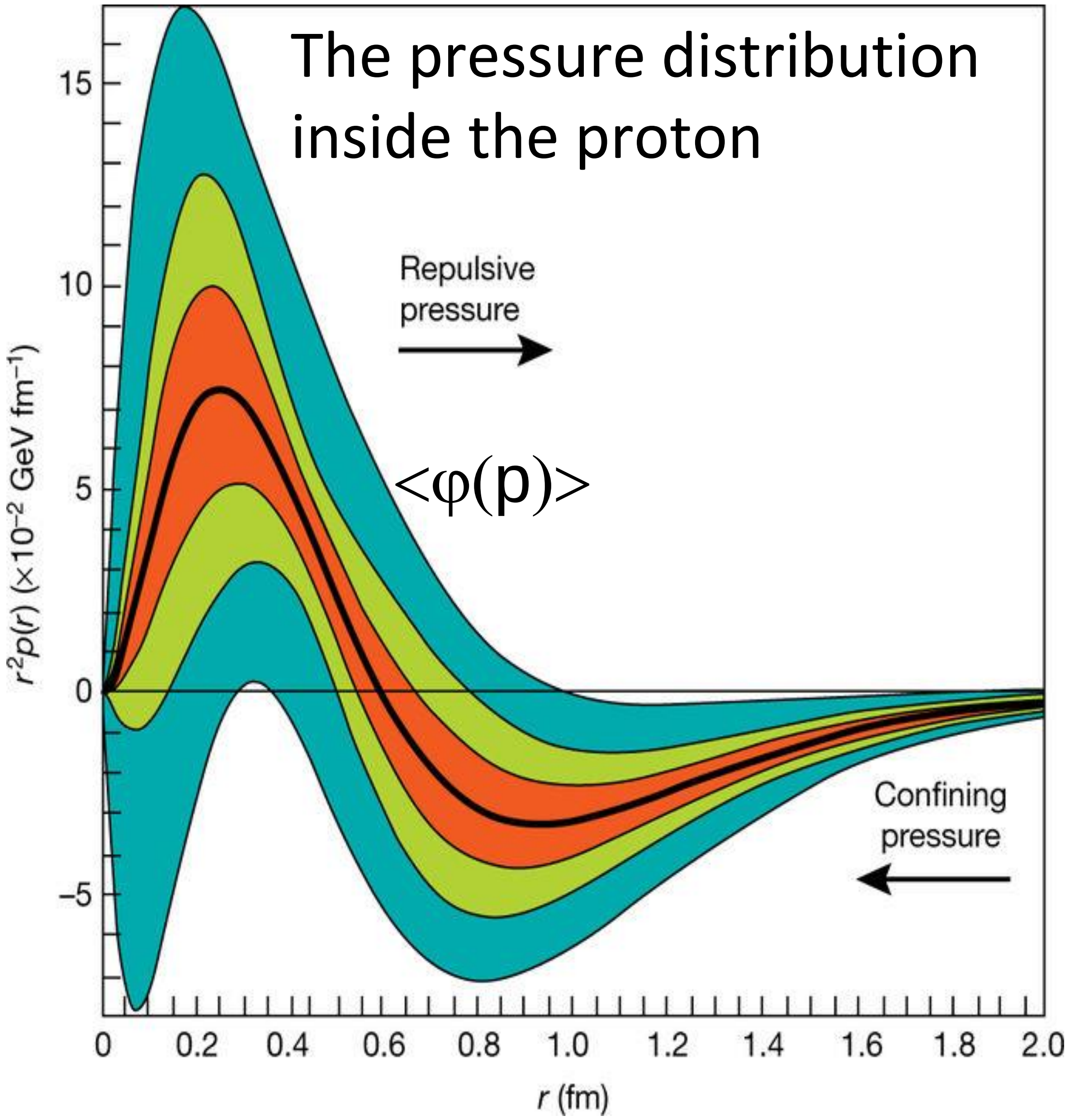


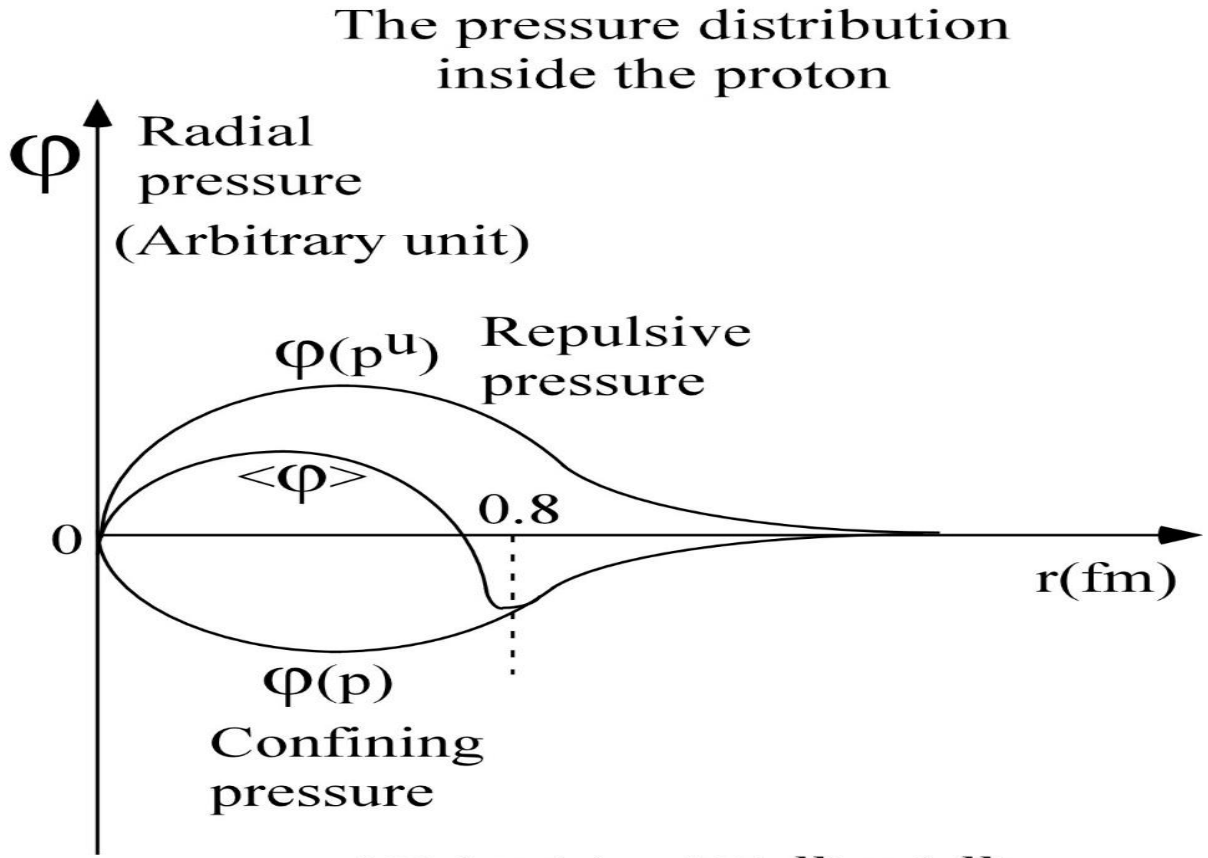
$$<\alpha_s> = \frac{N(p)}{N(p) + N(p^u)} = 0.2$$

Q: momentum transfered to quarks in deep inelastic scattering experiments

B. Fornal, B. Grinstein, arXiv:1801.01124

S. Bethke, arXiv:hep-ex/0606035





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

The pressure curves are plotted only for the explanation.

The <φ> curve corresponds to the experimental curve.

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

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.

Coulomb's constant
k(mm) = k(dd) = k
Neutral dark matter
$F_g(dd) >> F_c(dd) = 0$
at the present time

ESM (TQSM)

Coulomb's constant
k(mm) = k >> k(dd)
Charged dark matters
$F_g(dd) >> F_c(dd) > 0$
at the present time
k(mm): $\gamma(0,0)$
k(dd): $\gamma(0)$ dark photon

Big picture of Particle physics and Cosmology