Elementary particles, dark matter candidate and new extended standard model

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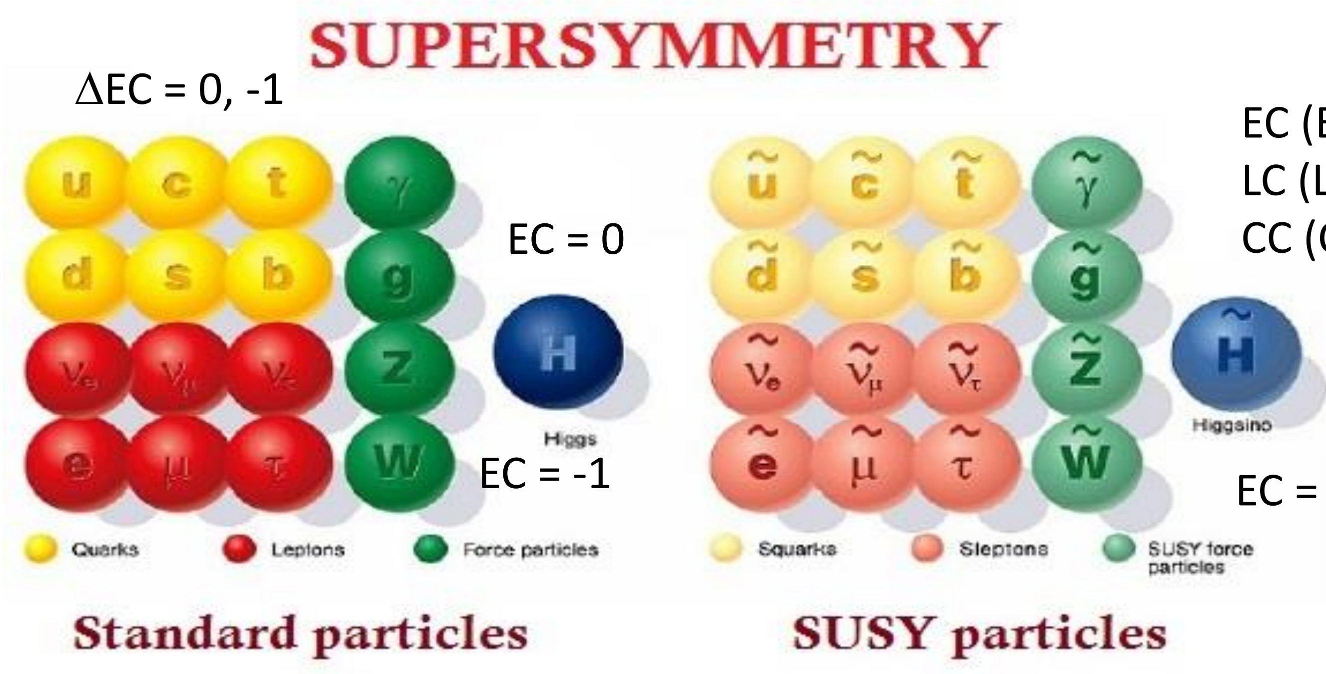
New physics search beyond the Standard Model



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

EC = 0 for the gluons

Techniquarks, Axion,
Leptoquarks, WIMP,
Z' boson (EC=0) $\longrightarrow$ $e + e^{+}$
W' boson (EC=-1) $\longrightarrow$ $b + \bar{t}$
Heavy quarks (EC): T(2/3), B(-1/3), X(5/3), Y(-4/3)
Sterile neutrino, Neutralinos, X- and Y- Bosons, Preons

Earlier Extended standard models

Standard model (SM)

Leptons				Quarks				
EC				EC				
0	ν_e	ν_μ	ν_τ	2/3	u	c	t	2 flavors
-1	e	μ	τ	-1/3	d	s	b	
-2	?	?	?	-4/3	?	?	?	← 3rd flavor is missing.
LC				LC				
n1	ν_e	e	?	N1	u	d	?	
n2	ν_μ	μ	?	N2	c	s	?	3 flavors (3 generations)
n3	ν_τ	τ	?	N3	t	b	?	
				CC				
				r				
SM: 6 leptons, 18 quarks				g				3 flavors
ESM: 9 leptons, 27 quarks				b				

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

e(EC,LC) = e(-1,n1). s(EC,LC,CC) = s(-1/3,N2,b) = s(-1/3,N2)CC(b) = s(b)

Force carrying bosons: EC = 0(Z,gluons), -1(W^-) for weak force and strong force

Extended Standard model (ESM)

Missing particles (EC)				Leptons(EC,LC)				Quarks(EC,LC,CC)			
EC				EC				EC			
d1	?			0	ν_e	ν_μ	ν_τ	2/3	u	c	t
d2	?			-1	e	μ	τ	-1/3	d	s	b
d3	?			-2	Le	Lμ	Lτ	-4/3	Q1	Q2	Q3
				LC				LC			
				n1	ν_e	e	Le	N1	u	d	Q1
				n2	ν_μ	μ	Lμ	N2	c	s	Q2
				n3	ν_τ	τ	Lτ	N3	t	b	Q3
								CC			
								r			
								g			
								b			

SM: 6 leptons, 18 quarks
ESM: 3 missing particles,
9 leptons, 27 quarks

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

e(EC,LC) = e(-1,n1). s(EC,LC,CC) = s(-1/3,N2,b) = s(-1/3,N2)CC(b) = s(b)

Extended Standard model (ESM)

Dark matters				Normal matters				Normal matters (Hadrons)			
Bastons (EC)				Leptons(EC,LC)				Quarks(EC,LC,CC)			
EC				EC				EC			
d1	B1			0	ν_e	ν_μ	ν_τ	2/3	u	c	t
d2	B2			-1	e	μ	τ	-1/3	d	s	b
d3	B3			-2	Le	Lμ	Lτ	-4/3	Q1	Q2	Q3
				LC				LC			
				n1	ν_e	e	Le	N1	u	d	Q1
				n2	ν_μ	μ	Lμ	N2	c	s	Q2
				n3	ν_τ	τ	Lτ	N3	t	b	Q3
								CC			
								r			
								g			
								b			

SM: 6 leptons, 18 quarks
ESM: 3 bastons (dark matters),
9 leptons, 27 quarks

B1(EC) = B1(d1) e(EC,LC) = e(-1,n1) s(EC,LC,CC) = s(-1/3,N2,b)

The charge quantizations are missing here except the ECs of leptons and quarks.

	Bastons (EC)				Leptons(EC,LC)				Quarks(EC,LC,CC)			
	EC				EC				EC			
	d1	B1			0	ν_e	ν_μ	ν_τ	2/3	u	c	t
	d2	B2			-1	e	μ	τ	-1/3	d	s	b
	d3	B3			-2	Le	$L\mu$	$L\tau$	-4/3	Q1	Q2	Q3
Total	-5				-3				-1			
					LC				LC			
					n1	ν_e	e	Le	N1	u	d	Q1
					n2	ν_μ	μ	$L\mu$	N2	c	s	Q2
					n3	ν_τ	τ	$L\tau$	N3	t	b	Q3
Total					-5				-3			
									CC			
									r			
									g			
									b			
Total									-5			

-1 = 2/3 -1/3 -4/3

-3 = 0 -1 -2

-5 = -2/3 -5/3 -8/3

Quark(EC,LC)CC = Quark (EC,LC,CC). s(-1/3,N2)CC(g) = s(-1/3,N2,g) = s(g)

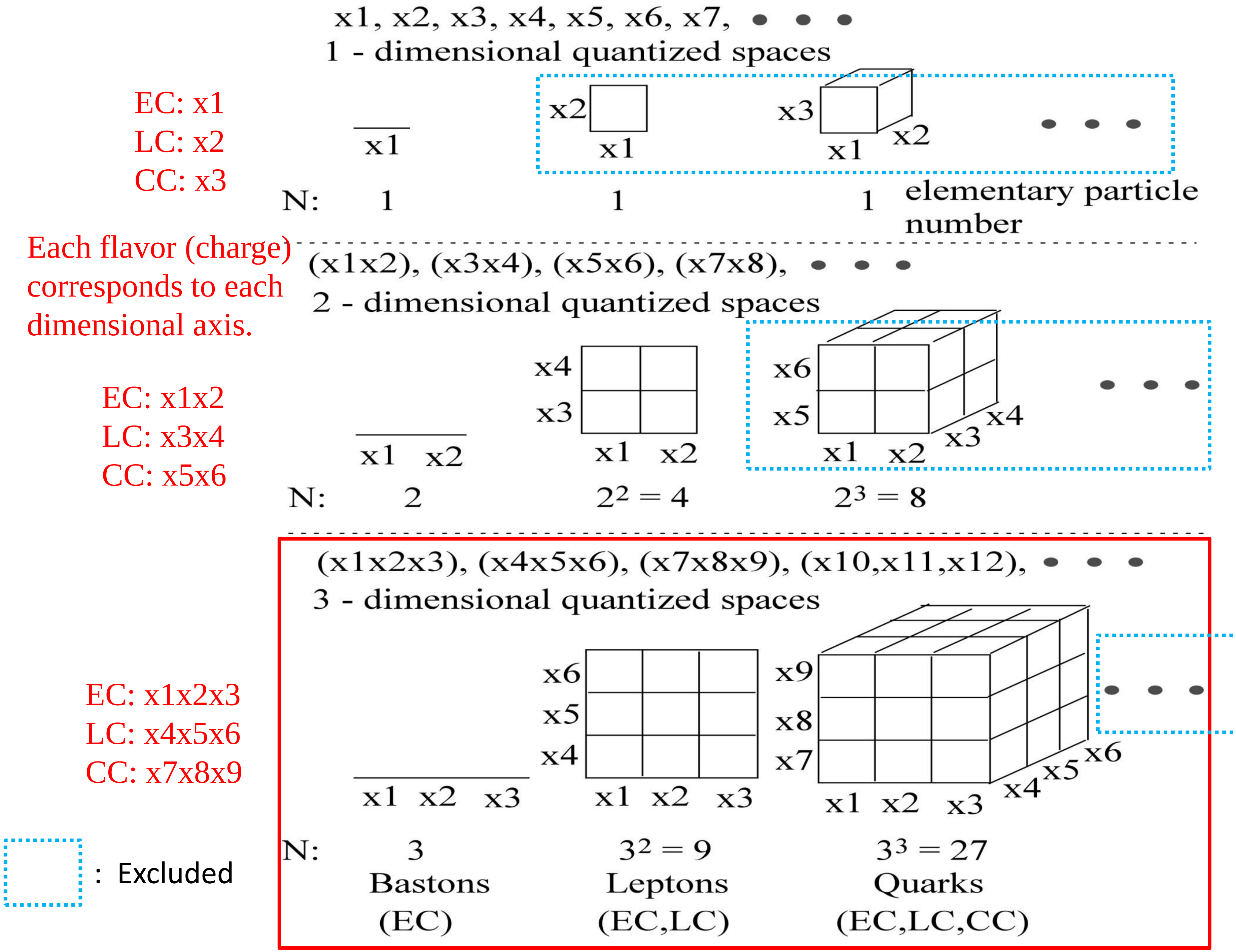
Complete table of the elementary fermions in Extended Standard Model (ESM)

	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			

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

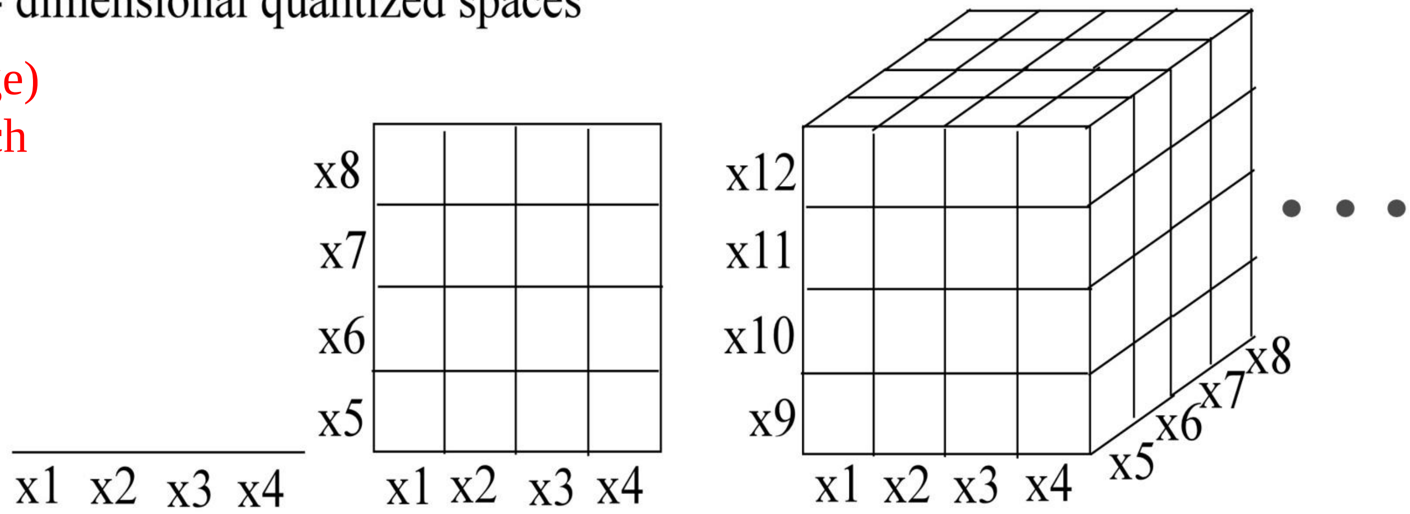

x1, x2, x3, x4, x5, x6, x7, • • •
1 - dimensional quantized spaces
EC: x1
LC: x2
CC: x3
x1
x2
x1
x3
x1
x2
• • •
N: 1
1
1
elementary particle number
Each flavor (charge) corresponds to each dimensional axis.
(x1x2), (x3x4), (x5x6), (x7x8), • • •
2 - dimensional quantized spaces
EC: x1x2
LC: x3x4
CC: x5x6
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
Bastons
(EC)
3² = 9
Leptons
(EC,LC)
3³ = 27
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.

Space dimensions should be cut-off by the negative charge condition of the matters.

Table 1. n-dimensional quantized spaces and their quantized charges assigned systematically to the matters (see Table 3). These have the space dimensions of N=n(n+1). Antimatters have the charges of –Q(-Q1,…,-Qn) opposite to the charges of matters. N_{ep} is the number of the elementary fermion particles. $Q_i - Q_{i-1} = -1$.

(n,N)	*Q(Q1,…,Qn)*	N_{ep}
(1,2)	*-1(-1)*	*1*
(2,6)	*-2(-1/2,-3/2)* *-4 (-3/2,-5/2)*	*6*
(3,12) (our universe)	*-1(2/3,-1/3,-4/3)* *-3(0,-1,-2)* *-5(-2/3,-5/3,-8/3)*	*39*
(4,20)	*-2(1,0,-1,-2)* *-4(1/2,-1/2,-3/2,-5/2)* *-6(0, -1, -2, -3)* *-8(-1/2,-3/2,-5/2,-7/2)*	*340*
(n,n(n+1))	*……..*	$\sum_{i=1}^{n} n^i$

Complete table of the elementary fermions in Extended Standard Model (ESM)

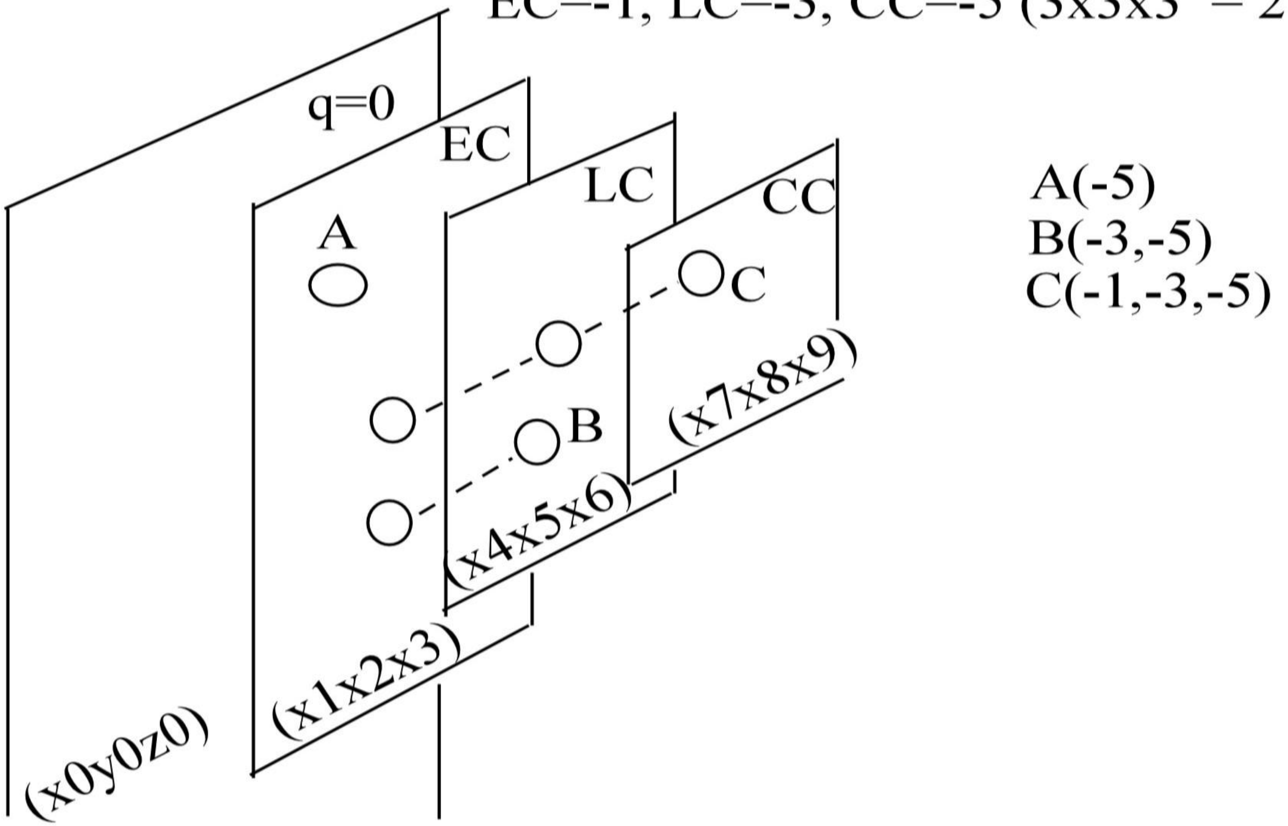
	Bastons (EC)				Leptons(EC,LC)				Quarks(EC,LC,CC)			
	EC				EC				EC			
X1	-2/3	B1			0	ν_e	ν_μ	ν_τ	2/3	u	c	t
X2	-5/3	B2			-1	e	μ	τ	-1/3	d	s	b
X3	-8/3	B3			-2	Le	Lμ	Lτ	-4/3	Q1	Q2	Q3
Total	-5				-3				-1			
					LC				LC			
X4					-2/3	ν_e	e	Le	0	u	d	Q1
X5					-5/3	ν_μ	μ	Lμ	-1	c	s	Q2
X6					-8/3	ν_τ	τ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

Each flavor (charge) corresponds to each dimensional axis.

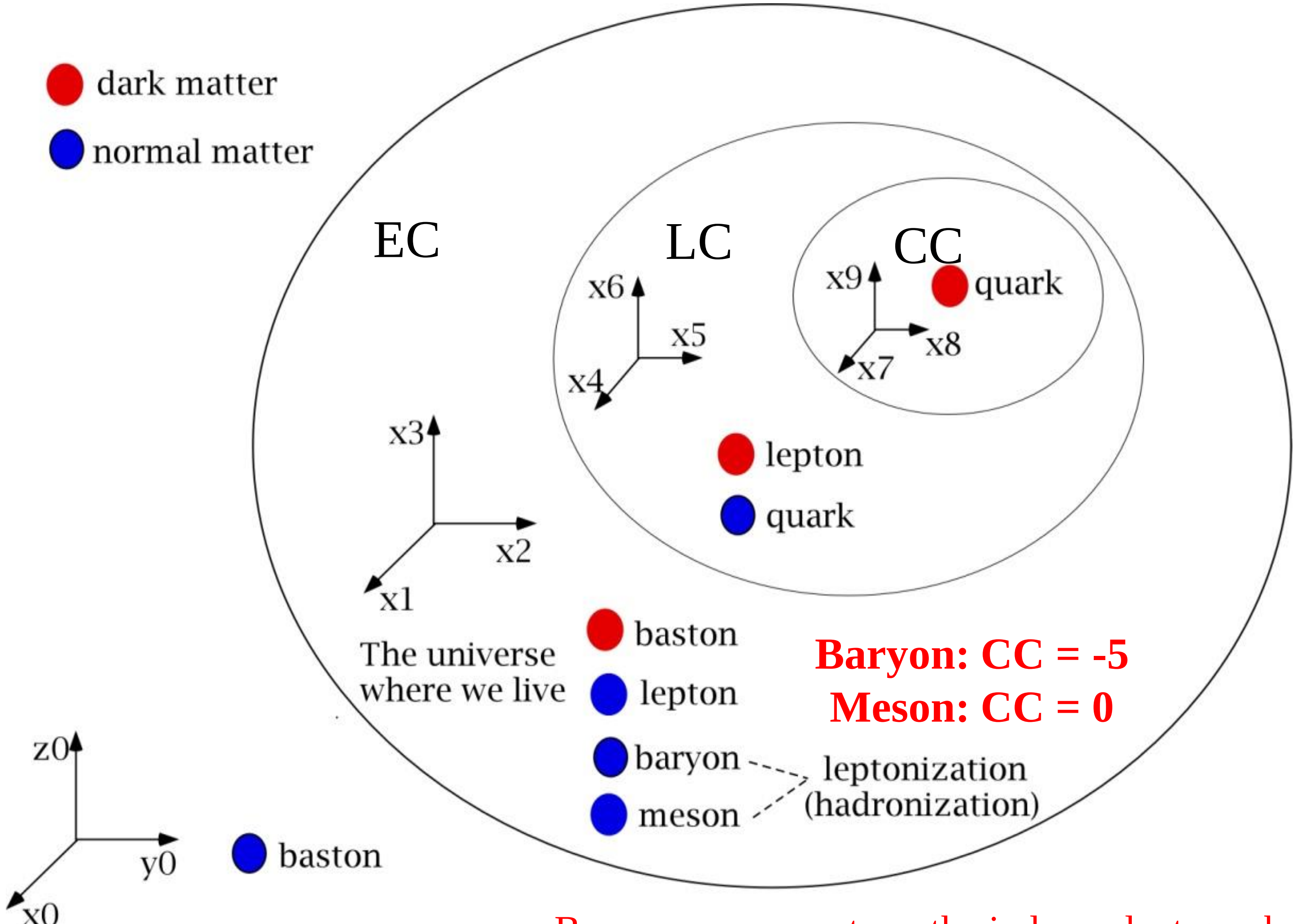
In SM, the 3 generations have the unsolved origin.
In ESM, the 3 generations (flavors) are originated from the 3 dimensional quantized space

Three-dimensional quantized space model
(New extended standard model)

Matters (q < 0) with E>0:
A: x1x2x3 minimum warped quantum: EC = -5 (3 bastons)
B: x1x2x3-x4x5x6 minimum warped quantum: EC=-3, LC=-5
(3x3=9 leptons)
C: x1x2x3-x4x5x6-x7x8x9 minimum warped quantum:
EC=-1, LC=-3, CC=-5 (3x3x3 = 27 quarks)



Three-dimensional quantized space model
(New extended standard model)



Because we cannot see the independent quarks, we are in the x1x2x3 space (universe).

Force carrying bosons in Standard Model (SM)

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

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

-3 = 0 -1 -2

SM: 2 Z/W^- bosons, 8 gluons (color octet)

ESM: 3 dark matter force bosons,
9 weak force bosons, 27 strong force bosons

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)

ESM (Extended standard model)

SM

W^-

W^-

W^-

Z

Z

Z

W^-

W^-

Table 9. Relations between W/Z(EC,LC) bosons and mesons/leptons(EC,LC).

W and Z	Quarks(Mesons)	Leptons
W(-1, -2)	$b\bar{u}(B^-)$	$\tau\bar{\nu}_e$
W(-1, -1)	$s\bar{u}(K^-), b\bar{c}(B_c^-)$	$\mu\bar{\nu}_e, \tau\bar{\nu}_\mu$
W(-1, 0)	$d\bar{u}(\pi^-), s\bar{c}(D_s^-), b\bar{t}$	$e\bar{\nu}_e, \mu\bar{\nu}_\mu, \tau\bar{\nu}_\tau$
Z(0, -2)	$b\bar{d}(\bar{B}^0), t\bar{u}$	$\nu_\tau\bar{\nu}_e$, τe^+
Z(0, -1)	$s\bar{d}(\bar{K}^0), c\bar{u}(D^0), b\bar{s}(\bar{B}_s^0), t\bar{c}$	$\mu e^+, \tau\mu^+, \nu_\mu\bar{\nu}_e, \nu_\tau\bar{\nu}_\mu$
Z(0, 0)	$u\bar{u}(\pi^0), d\bar{d}, c\bar{c}, s\bar{s}, b\bar{b}$	$\nu_\tau\bar{\nu}_\tau, \nu_e\bar{\nu}_e, \nu_\mu\bar{\nu}_\mu$, $ee^+, \mu\mu^+, \tau\tau^+$
W(-1, 1)	$d\bar{c}(D^-)$, $s\bar{t}$	$e\bar{\nu}_\mu$, $\mu\bar{\nu}_\tau$
W(-1, 2)	$d\bar{t}$	$e\bar{\nu}_\tau$

Z/W/Y(EC,LC)CC = Z/W/Y(EC,LC,CC) for two quarks. For mesons CC=0.

(1) Possible experimental searches in LHC

Le, Lμ, Q1, Z(0,-1), W(-1,-1), Y(-2,0): TeV scale

SM	ESM (Extended standard model)			
Z	Z(0,-1)	μ(-1,-5/3) e^+(1,2/3)	ν_μ(0,-5/3) $\overline{\nu_e}$(0,2/3)	τ(-1,-8/3) $\bar{\mu}$(1,5/3)
Z	Z(0,-1)	L_μ(-2,-5/3) $\overline{L_e}$(2,2/3)		
Z	Z(0,0) 91.2 GeV/c²	e(-1,-2/3) e^+(1,2/3)	μ(-1,-5/3) $\bar{\mu}$(1,5/3)	
W^-	W(-1,-1)	μ(-1,-5/3) $\overline{\nu_e}$(0,2/3)	τ(-1,-8/3) $\overline{\nu_\mu}$(0,5/3)	L_μ(-2,-5/3) e^+(1,2/3)
W^-	W(-1,0) 80.4 GeV/c²	$\overline{\nu_e}$(0,2/3) e(-1,-2/3)	$\overline{\nu_\mu}$(0,5/3) μ(-1,-5/3)	
	Y(-2,0)	$\overline{\nu_e}$(0,2/3) L_e(-2,-2/3)	$\overline{\nu_\mu}$(0,5/3) L_μ(-2,-5/3)	

Table 3. Electric charges (EC), lepton charges (LC) and color charges (CC) for the elementary fermion particles. Red colored ones have been previously known. All charges are normalized to ECs of e (EC=-1) and ν_e (EC=0). u(r) = (2/3.0,-2/3)=(EC,LC,CC).

EC flavor	x1x2x3	x1x2x3	x1x2x3
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 EC	-5	-3	-1
LC flavor		x4x5x6	x4x5x6
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 LC		-5	-3
CC flavor			x7x8x9
x7			-2/3(r)
x8			-5/3(g)
x9			-8/3(b)
Total CC			-5

Bastons (dark matters), Leptons, Quarks

Baryon: CC = -5 (3 quarks)

Meson: CC = 0 (quark - anti quark)

Paryon: LC = -5 (3 leptons)

Koron: LC = 0 (lepton - anti lepton)

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

Meson: π^0 (u $\bar{u}$)(0,0,0)

Koron: π_l^0 (e^+e^-)(0,0)

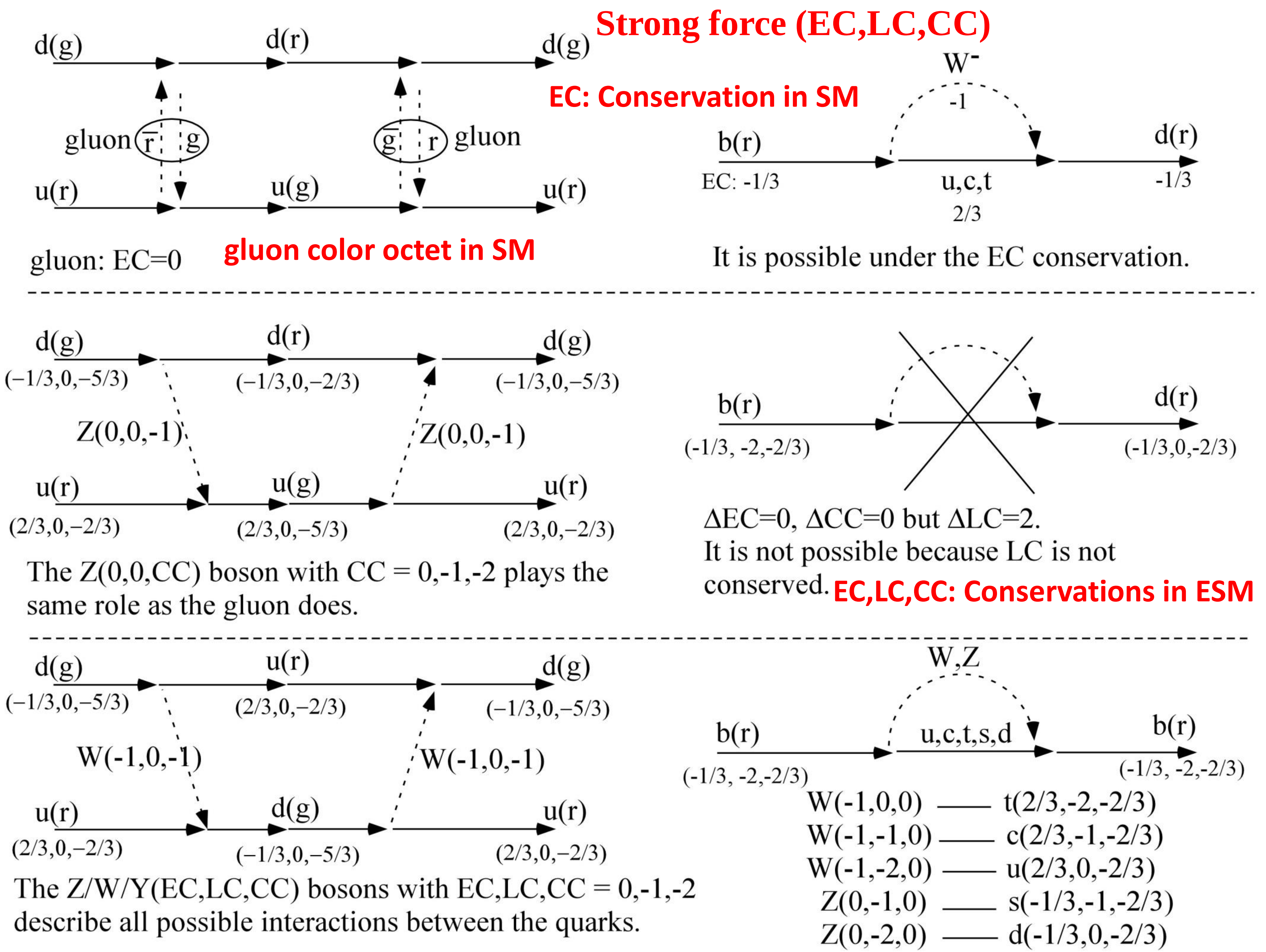
Z/W/Y(EC,LC,0) ⟷ Z/W/Y(EC,LC)

Z/W/Y(EC,0) ⟷ Z/W/Y(EC)

Gluons are replaced with these bosons.

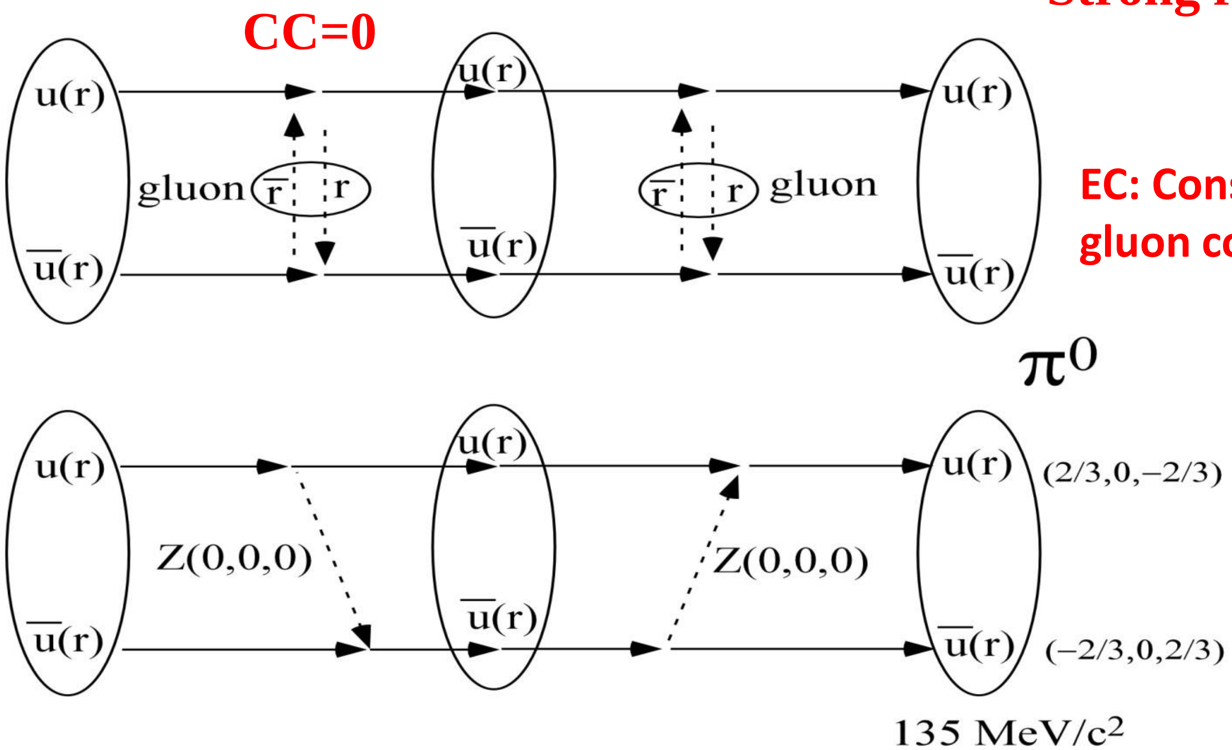
EC flavor	x1x2x3	x1x2x3	x1x2x3
x1	0 Z(0)	0 Z(0,0),Z(0,−1),Z(0,−2)	0 Z(0,0),Z(0,-1),Z(0,-2)
x2	-1 W(-1)	-1 W(-1,0),W(-1,-1),W(-1,-2)	-1 W(-1,0),W(-1,-1),W(-1,-2)
x3	-2 Y(-2)	-2 Y(-2,0),Y(-2,-1),Y(-2,-2)	-2 Y(-2,0),Y(-2,-1),Y(-2,-2)
Total EC	-3	-3	-3
LC flavor		x4x5x6	x4x5x6
x4		0 Z(0,0),W(−1,0),Y(−2,0)	0 Z(0,0),W(-1,0),Y(-2,0)
x5		-1 Z(0,−1),W(−1,−1),Y(−2,−1)	-1 Z(0,-1),W(-1,-1),Y(-2,-1)
x6		-2 Z(0,−2),W(−1,−2),Y(−2,−2)	-2 Z(0,-2),W(-1,-2),Y(-2,-2)
Total LC		-3	-3
CC flavor			x7x8x9
x7			0 CC(0)
x8			-1 CC(-1)
x9			-2 CC(-2)
Total CC			-3

Dark matter force, Weak force, Strong force


Strong force (EC,LC,CC)
d(g)
d(r)
d(g)
gluon r̄ g
ḡ r gluon
u(r)
u(g)
u(r)
gluon: EC=0
gluon color octet in SM
EC: Conservation in SM
W-
-1
b(r)
d(r)
EC: -1/3
u,c,t
2/3
-1/3
It is possible under the EC conservation.
d(g)
(−1/3,0,−5/3)
d(r)
(−1/3,0,−2/3)
d(g)
(−1/3,0,−5/3)
Z(0,0,-1)
Z(0,0,-1)
u(r)
(2/3,0,−2/3)
u(g)
(2/3,0,−5/3)
u(r)
(2/3,0,−2/3)
The Z(0,0,CC) boson with CC = 0,-1,-2 plays the same role as the gluon does.
b(r)
(-1/3, -2,-2/3)
d(r)
(-1/3,0,-2/3)
ΔEC=0, ΔCC=0 but ΔLC=2.
It is not possible because LC is not conserved.
EC,LC,CC: Conservations in ESM
d(g)
(−1/3,0,−5/3)
u(r)
(2/3,0,−2/3)
d(g)
(−1/3,0,−5/3)
W(-1,0,-1)
W(-1,0,-1)
u(r)
(2/3,0,−2/3)
d(g)
(−1/3,0,−5/3)
u(r)
(2/3,0,−2/3)
The Z/W/Y(EC,LC,CC) bosons with EC,LC,CC = 0,-1,-2 describe all possible interactions between the quarks.
W,Z
b(r)
(-1/3, -2,-2/3)
u,c,t,s,d
b(r)
(-1/3, -2,-2/3)
W(-1,0,0) —— t(2/3,-2,-2/3)
W(-1,-1,0) —— c(2/3,-1,-2/3)
W(-1,-2,0) —— u(2/3,0,-2/3)
Z(0,-1,0) —— s(-1/3,-1,-2/3)
Z(0,-2,0) —— d(-1/3,0,-2/3)

Meson (quark - anti quark)

Strong force (EC,LC,CC)

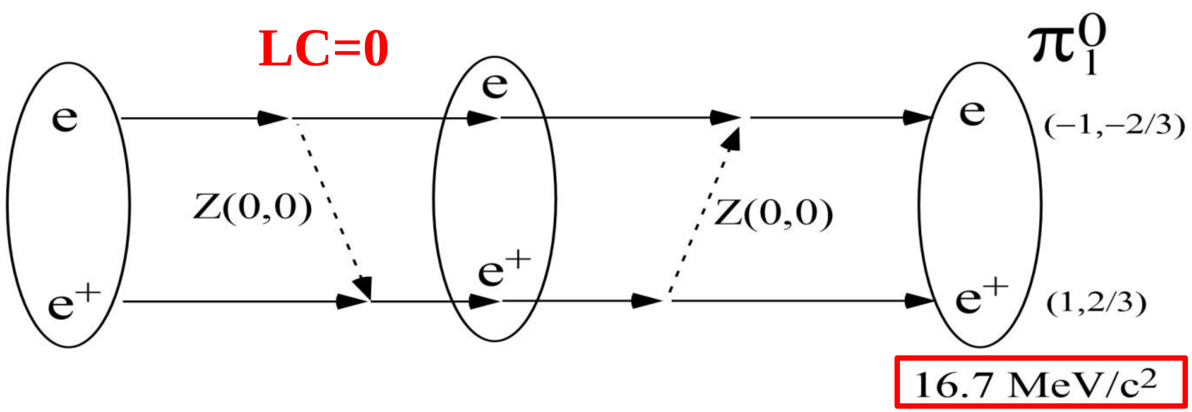


EC: Conservation in SM, gluon color octet in SM

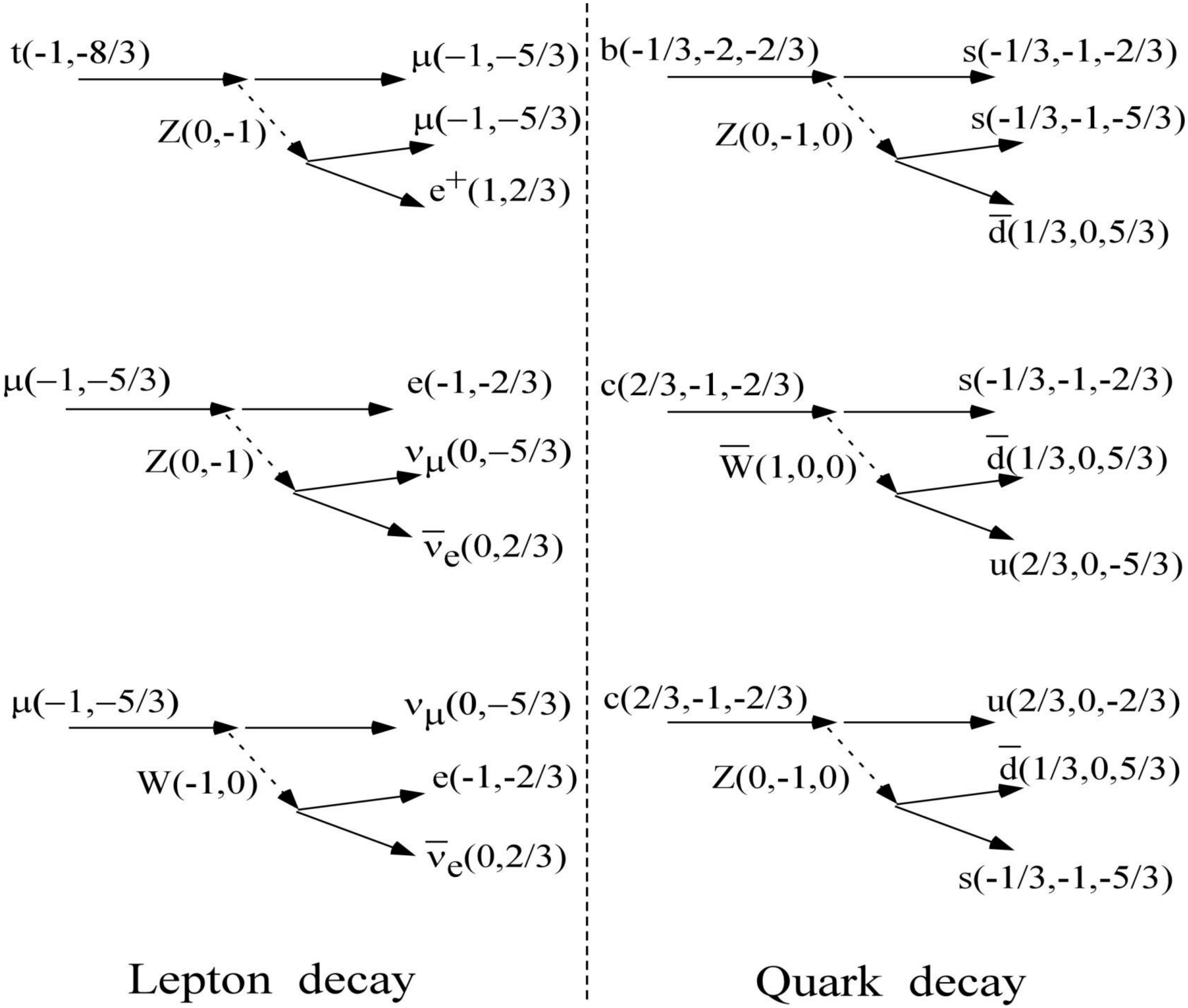
EC,LC,CC: Conservations in ESM

Koron (lepton - anti lepton)

Weak force (EC,LC)



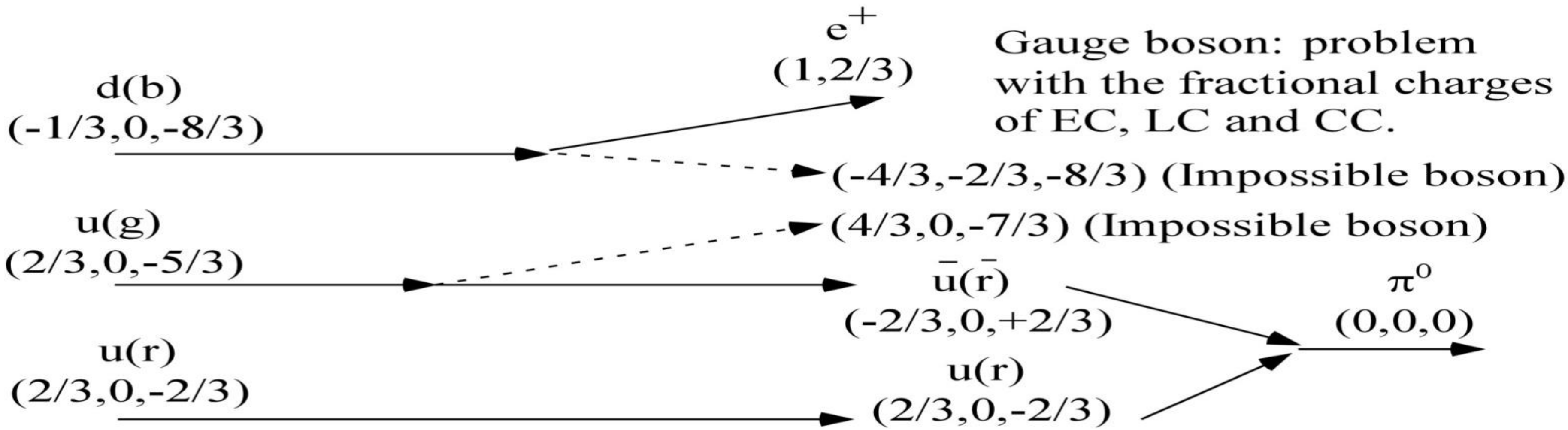
EC,LC: Conservations in ESM

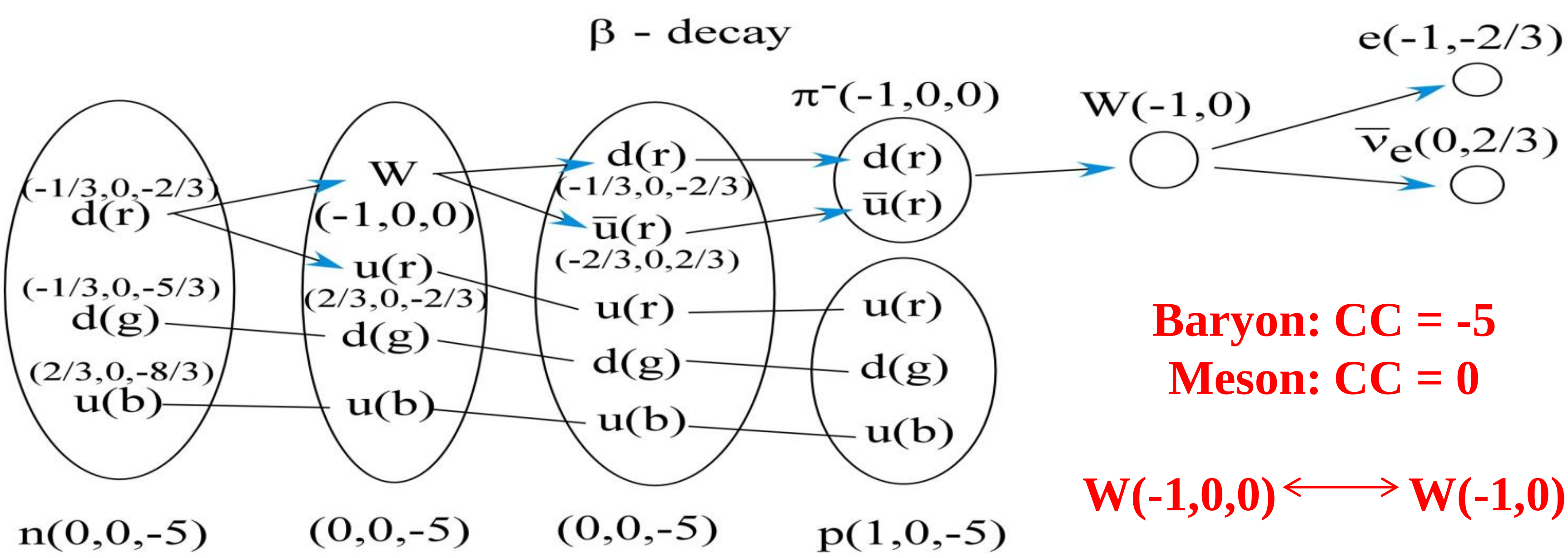


EC,LC,CC: Conservations in ESM (Extended standard model)

$p\ (1,0,-5) \longrightarrow e^{+}\ (1,2/3) + \pi^{0}\ (0,0,0)$

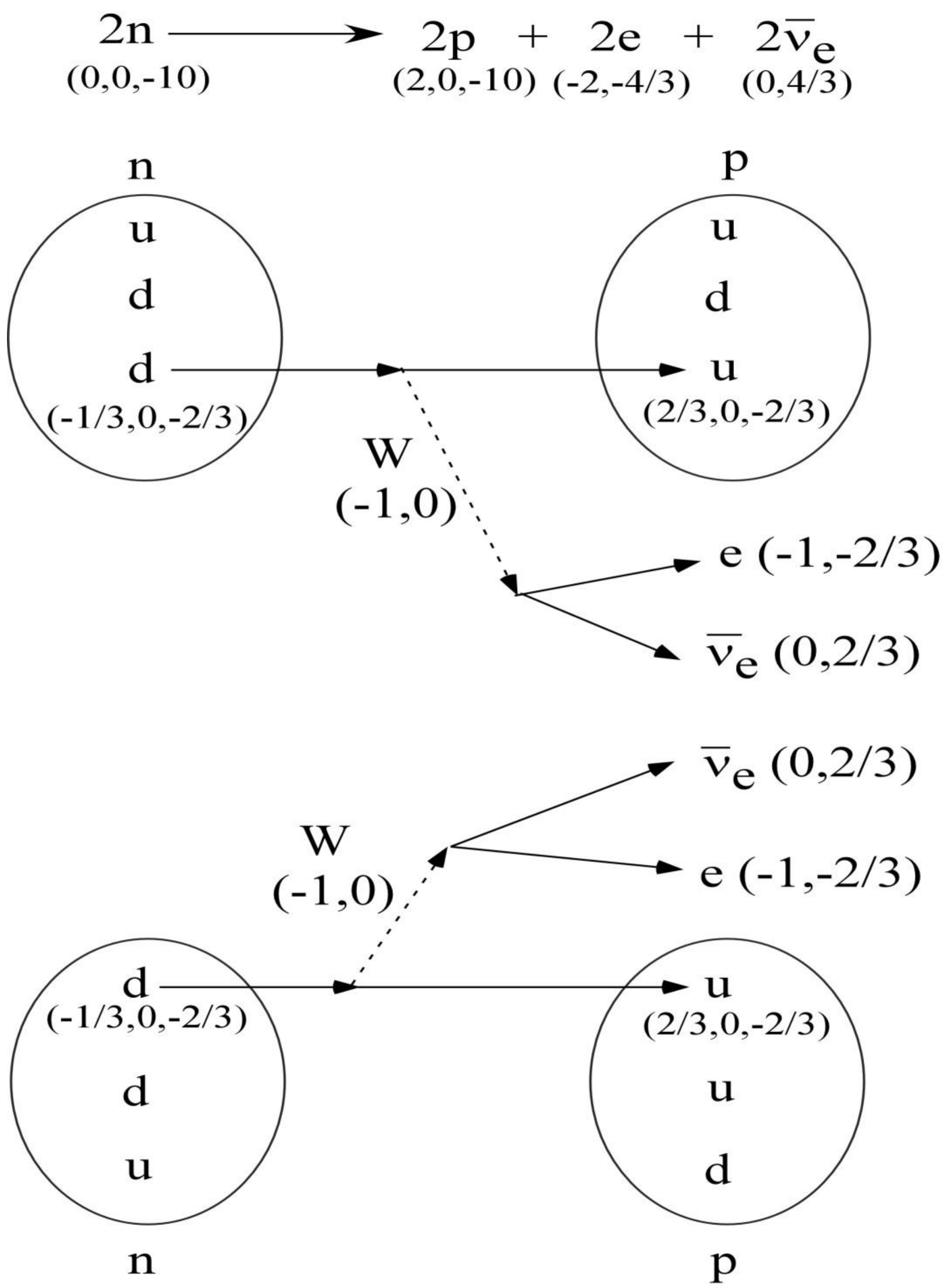
EC: Conserved
LC,CC: not conserved





Baryon: CC = -5
Meson: CC = 0

W(-1,0,0) ⟷ W(-1,0)



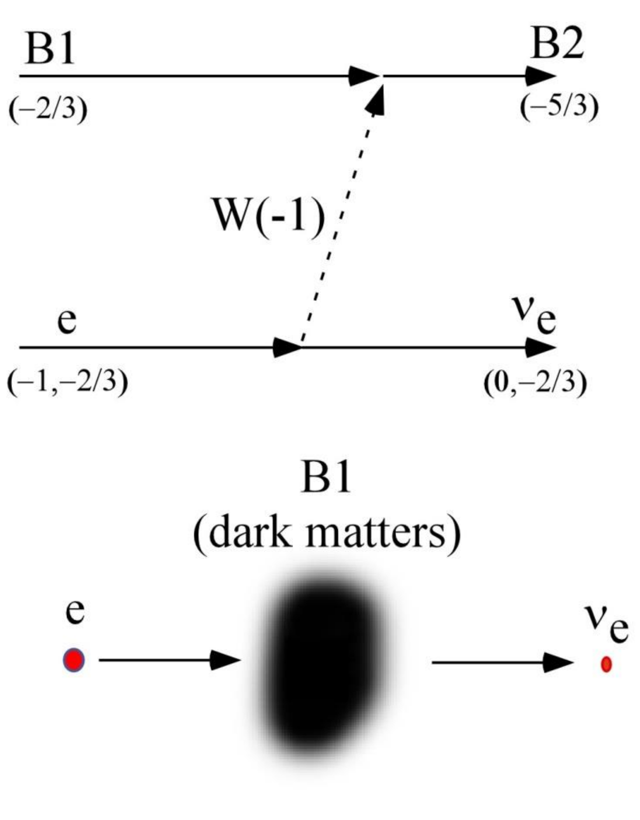
Double beta decay should have two electron anti-neutrinos.

The neutrino is not the Majorana particle because of the non-zero lepton charge (LC).

Baryon: CC = -5
Meson: CC = 0

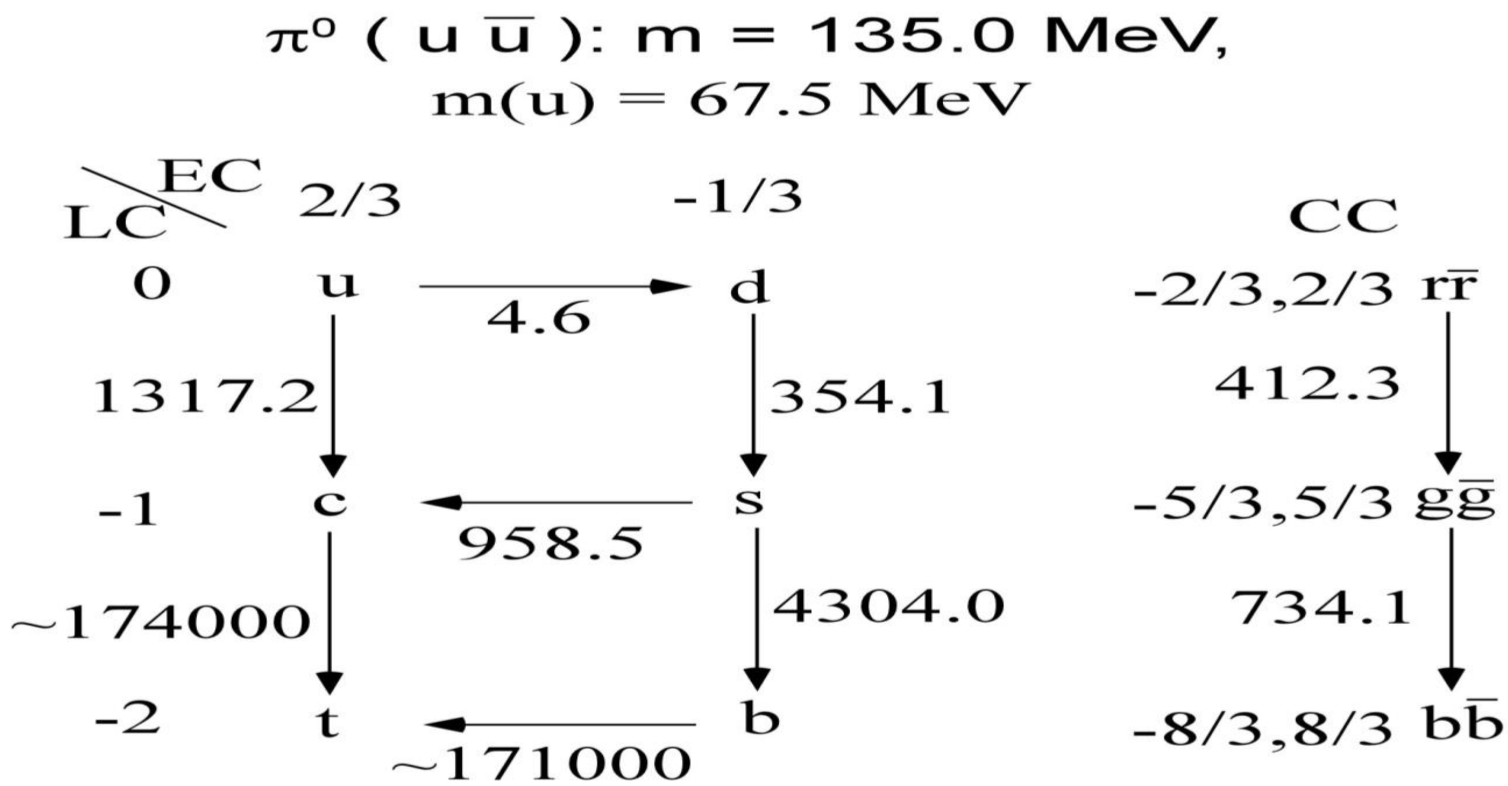
W(-1,0,0) ⟷ W(-1,0)

Source of the enhanced cosmic ν_e and ν_μ neutrinos



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.

Charge configurations of mesons



Meson: CC = 0

Meson energies and quark charges

Quark excitation energies associated with the mesons.

Mesons	$q\bar{q}$	(EC,LC,CC)($\overline{EC},\overline{LC},\overline{CC}$)	Exp. (MeV)	Calc. (MeV)
π^0	$u\bar{u}$	(2/3,0,-2/3) (-2/3,0,2/3)	135.0	135.0
η	$u\bar{u}$	(2/3,0,-5/3) (-2/3,0,5/3)	547.3	547.3
$f_1(1285)$	$u\bar{u}$	(2/3,0,-8/3) (-2/3,0,8/3)	1285	1281.4
π^+	$u\bar{d}$	(2/3,0,-2/3) (1/3,0,2/3)	139.6	139.6
$f_0(550)$	$u\bar{d}$	(2/3,0,-5/3) (1/3,0,5/3)	550	551.9
$\eta(1295)$	$u\bar{d}$	(2/3,0,-8/3) (1/3,0,8/3)	1295	1286.0
K^+	$u\bar{s}$	(2/3,0,-2/3) (1/3,1,2/3)	493.7	493.7
$K^*(892)^+$	$u\bar{s}$	(2/3,0,-5/3) (1/3,1,5/3)	891.7(3)	906
$K_1(1650)$	$u\bar{s}$	(2/3,0,-8/3) (1/3,1,8/3)	1650	1640
K^0	$d\bar{s}$	(-1/3,0,-2/3) (1/3,1,2/3)	497.7	498.3

Mesons	$q\bar{q}$	(EC,LC,CC)($\overline{EC},\overline{LC},\overline{CC}$)	Exp. (MeV)	Calc. (MeV)
$K^{+}(892)^{0}$	$d\bar{s}$	(-1/3,0,-5/3) (1/3,1,5/3)	896.1(3)	910.6
$K_2(1780)$	$d\bar{s}$	(-1/3,0,-8/3) (1/3,1,8/3)	1776(7)	1644.7
D^+	$c\bar{d}$	(2/3,-1,-5/3) (1/3,0,5/3)	1869.3(5)	1869.1
D^0	$c\bar{u}$	(2/3,-1,-5/3) (-2/3,0,5/3)	1864.5(5)	1864.5
D_s^+	$c\bar{s}$	(2/3,-1,-2/3) (1/3,1,2/3)	1968.6(6)	1810.9
B^+	$u\bar{b}$	(2/3,0,-5/3) (1/3,2,5/3)	5279.0(5)	5210.0
B_s^0	$s\bar{b}$	(-1/3,-1,-2/3) (1/3,2,2/3)	5369.6(24)	5156.4
B_c^+	$c\bar{b}$	(2/3,-1,-2/3) (1/3,2,2/3)	6276(4)	6114.9
η_c	$c\bar{c}$	(2/3,-1,-2/3) (-2/3,1,2/3)	2979.8(18)	2749.4
J/ψ	$c\bar{c}$	(2/3,-1,-5/3) (-2/3,1,5/3)	3096	3171.7
X(3872)	$c\bar{c}$	(2/3,-1,-8/3) (-2/3,1,8/3)	3872	3905.8
γ	$b\bar{b}$	(-1/3,-2,-2/3) (1/3,2,2/3)	9460.3(3)	9460.4

π_d^0 144.2 MeV ---------------- π^0 135 MeV

$d\bar{d}$ (-1/3,0,-2/3) (1/3,0,2/3) — $u\bar{u}$ (2/3,0,-2/3) (-2/3,0,2/3)

η_d 556.5 MeV ---------------- η 547.3 MeV

$d\bar{d}$ (-1/3,0,-5/3) (1/3,0,5/3) — $u\bar{u}$ (2/3,0,-5/3) (-2/3,0,5/3)

f_{1d} 1294.2 MeV ---------------- $f_1(1285)$

$d\bar{d}$ (-1/3,0,-8/3) (1/3,0,8/3) — $u\bar{u}$ (2/3,0,-8/3) (-2/3,0,8/3)

144.2 MeV π_d^0 $d\bar{d}$ $\longrightarrow$ 2γ (?) New

(-1/3,0,-2/3) (1/3,0,2/3) — (0,0) (0,0)

139.6 MeV π^+ $u\bar{d}$ $\longrightarrow$ $\mu^+ + \nu_\mu$

(2/3,0,-2/3) (1/3,0,2/3) — (1,5/3) (0,-5/3)

$\frac{u\bar{u} - d\bar{d}}{\sqrt{2}}$ 135 MeV π^0 $u\bar{u}$ $\longrightarrow$ 2γ

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

(1) Possible experimental searches in LHC

Le, Lμ, Q1, Z(0,-1), W(-1,-1), Y(-2,0): TeV scale

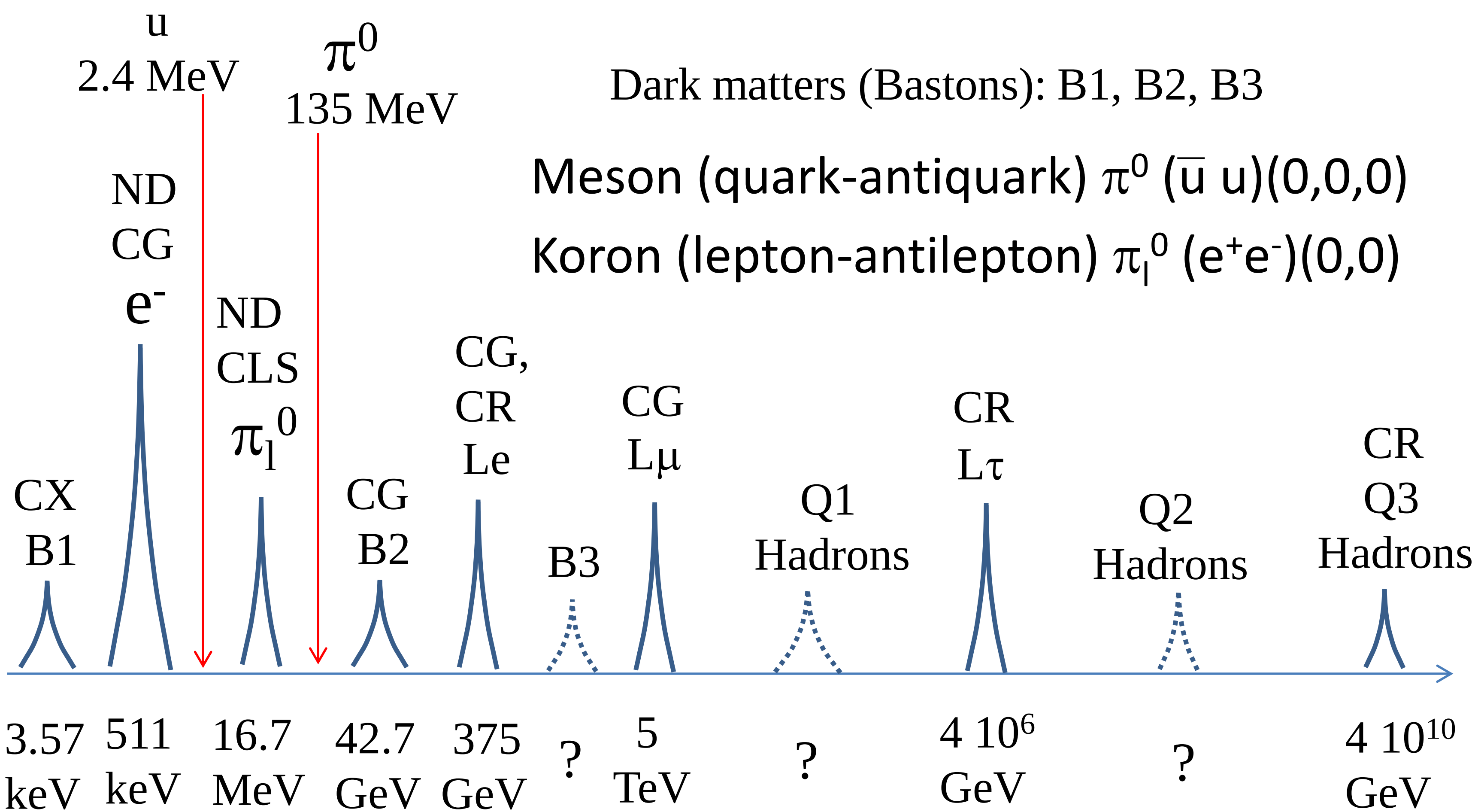
Z(0,-1)	$\mu(-1,-5/3)$ $e^{+}(1,2/3)$	$\nu_{\mu}(0,-5/3)$ $\overline{\nu_e}(0,2/3)$	$\tau(-1,-8/3)$ $\overline{\mu}(1,5/3)$
Z(0,-1)	$L_{\mu}(-2,-5/3)$ $\overline{L_e}(2,2/3)$		
Z(0,0) 91.2 GeV/c^2	$e(-1,-2/3)$ $e^{+}(1,2/3)$	$\mu(-1,-5/3)$ $\overline{\mu}(1,5/3)$	
W(-1,-1)	$\mu(-1,-5/3)$ $\overline{\nu_e}(0,2/3)$	$\tau(-1,-8/3)$ $\overline{\nu_\mu}(0,5/3)$	$L_{\mu}(-2,-5/3)$ $e^{+}(1,2/3)$
W(-1,0) 80.4 GeV/c^2	$\overline{\nu_e}(0,2/3)$ $e(-1,-2/3)$	$\overline{\nu_\mu}(0,5/3)$ $\mu(-1,-5/3)$	
Y(-2,0)	$\overline{\nu_e}(0,2/3)$ $L_e(-2,-2/3)$	$\overline{\nu_\mu}(0,5/3)$ $L_{\mu}(-2,-5/3)$	

(2) Possible searches from astronomical observations

Dark matters (Bastons): B1, B2, B3

Meson (quark-antiquark) π^0 ($\bar{u}$ u)(0,0,0)

Koron (lepton-antilepton) π_l^0 (e^+e^-)(0,0)



unit: $E=mc^2$

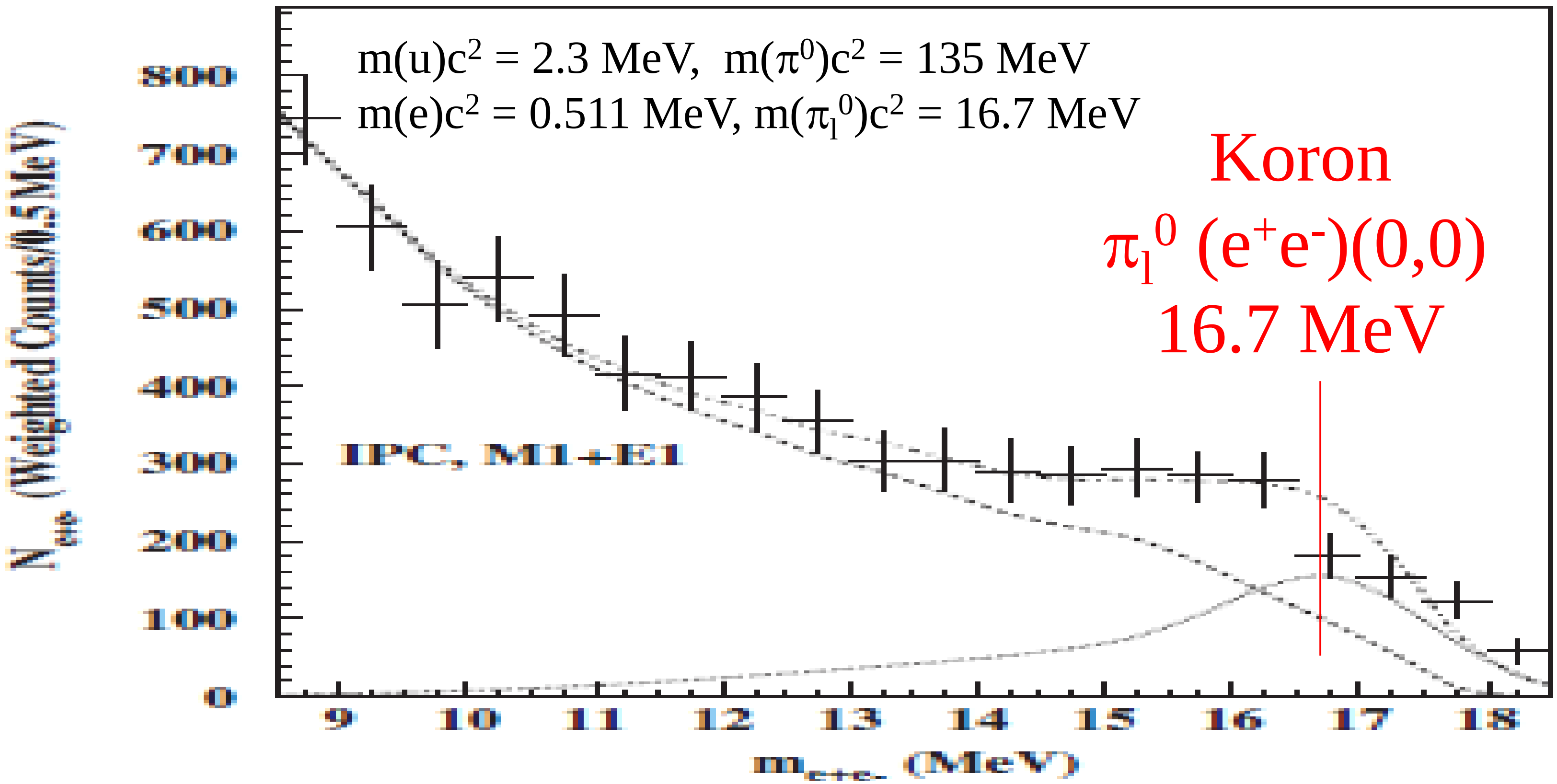
ND: Nuclear Decay, CLS: Cosmic Light Spectroscopy

NR: Nuclear Reaction

CG: Cosmic Gamma ray, CX: Cosmic X ray

CR: Cosmic ray

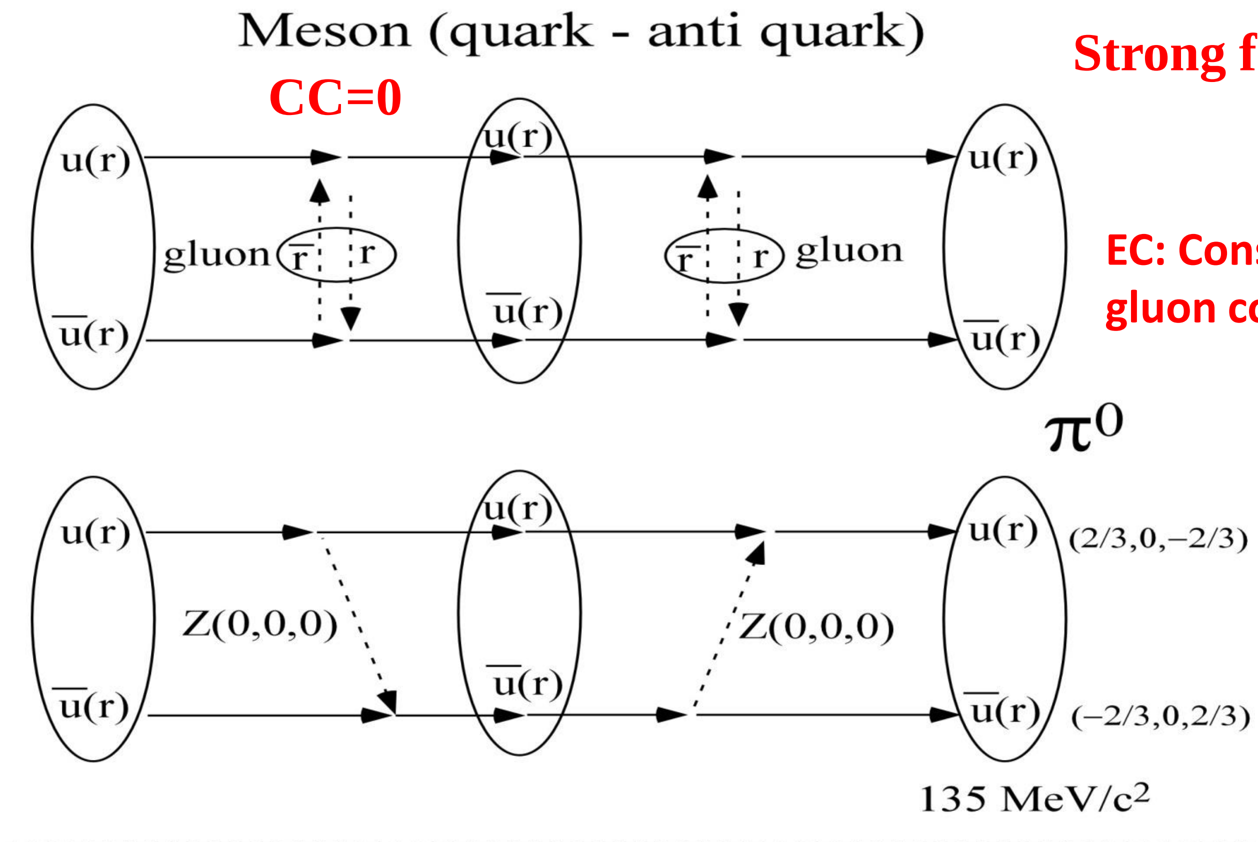
Rest masses of B1, B2, Le, Lμ, Lτ, Q3 are tentatively assigned for the further researches.



A.J. Krasznahorkay et al., Phys. Rev. Lett. 116, 042501 (2016). Invariant mass distribution from 18.15 MeV transition in ^8Be. X(16.70(35) MeV) peak with the spin of 1^+ is proposed as the first Koron observed experimentally.

Meson (quark-antiquark) π^0 $(u\,\bar{u})(0,0,0)$

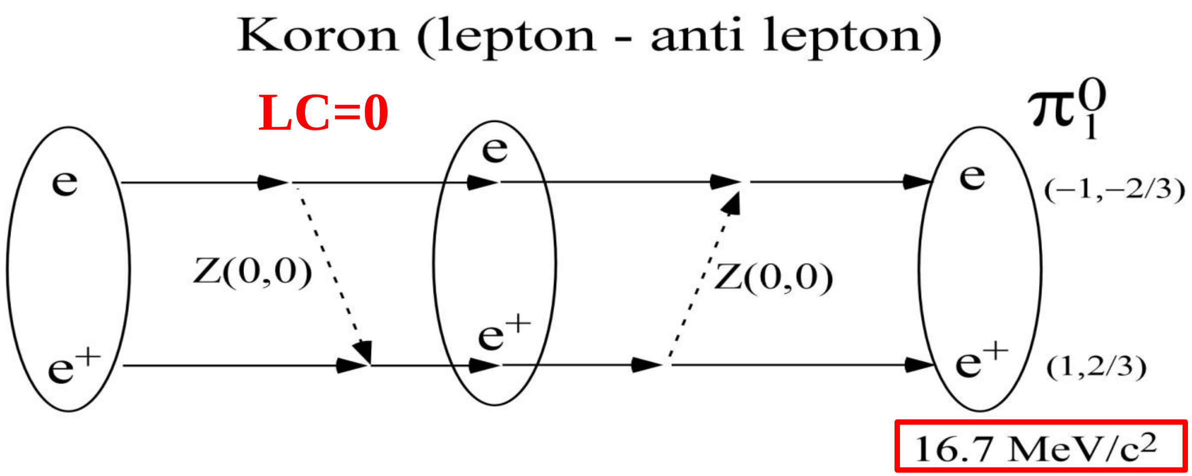
Koron (lepton-antilepton) π_l^0 $(e^+e^-)(0,0)$



Strong force (EC,LC,CC)

EC: Conservation in SM,
gluon color octet in SM

EC,LC,CC:
Conservations in ESM



Weak force (EC,LC)

EC,LC:
Conservations in ESM

Cosmological lithium abundance problem at the Big Bang Nucleosynthesis (BBN)

BBN prediction: (^{7}Li/H) = 4.68(67) 10^{-10}

R.H. Cyburf ey al., Rev. Mod. Phys. 88, 015004 (2016).

Observed value: (^{7}Li/H) = 1.6(3) 10^{-10}

L.Sbordone et al., Astron. Astrophys. 522, A26 (2010).

Solution: New neutral boson (X) with 1.6 MeV < $m_x c^2$ < 20 MeV and few 10^2 s < τ_x < 10^4 s.

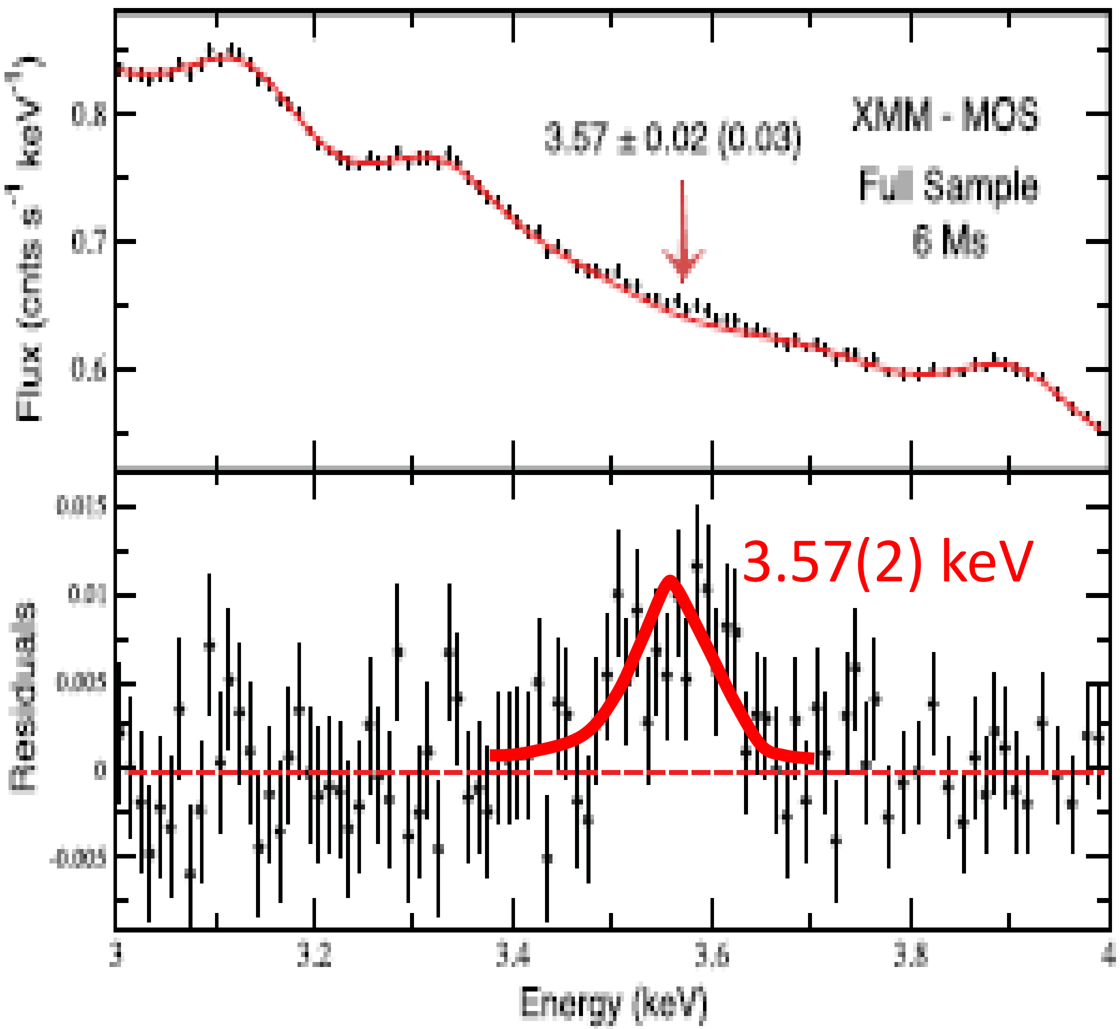
^{7}Be(X,α)^{3}He and D(X,p)n reactions will reduce the abundances of ^{7}Be and ^{7}Li.

A. Goudeis et al., Phys. Rev. Lett. 116, 211303 (2016).

Koron (lepton-antilepton) π_l^0 (e^+e^-)(0,0) with mc^2 = 16.70(35) MeV.

π_l^0 (e^+e^-) is the good candidate of the neutral boson (X) for the lithium problem.

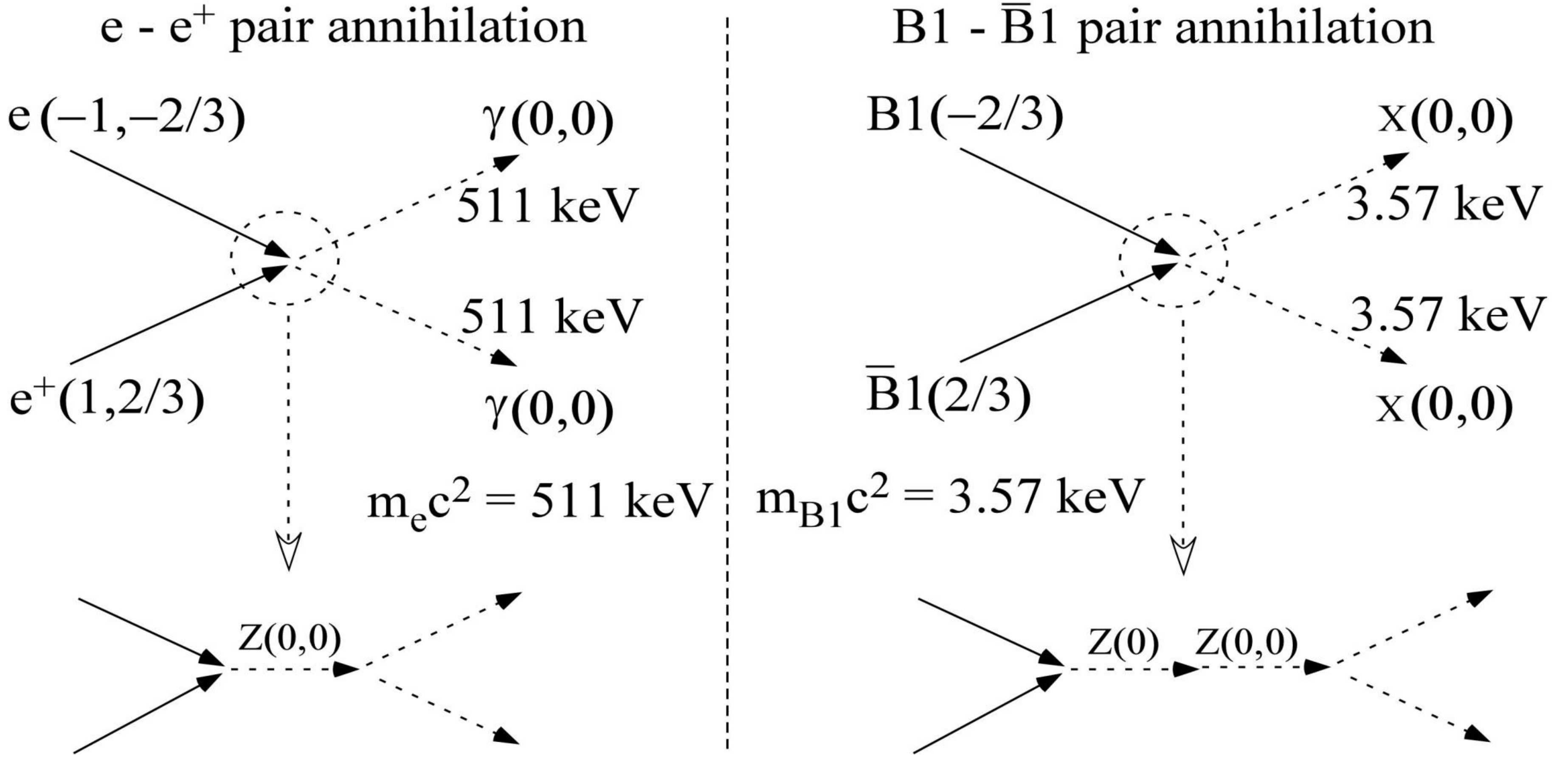
B1 fermionic dark matter measurements



The 3.57 (2) keV peak was identified in a stacked XMM-Newton MOS and PN x-ray spectrum.

E. Bulbul et al., Astrophys. J. 789, 13 (2014).

The 3.57 keV peak is proposed as the B1 annihilation peak .



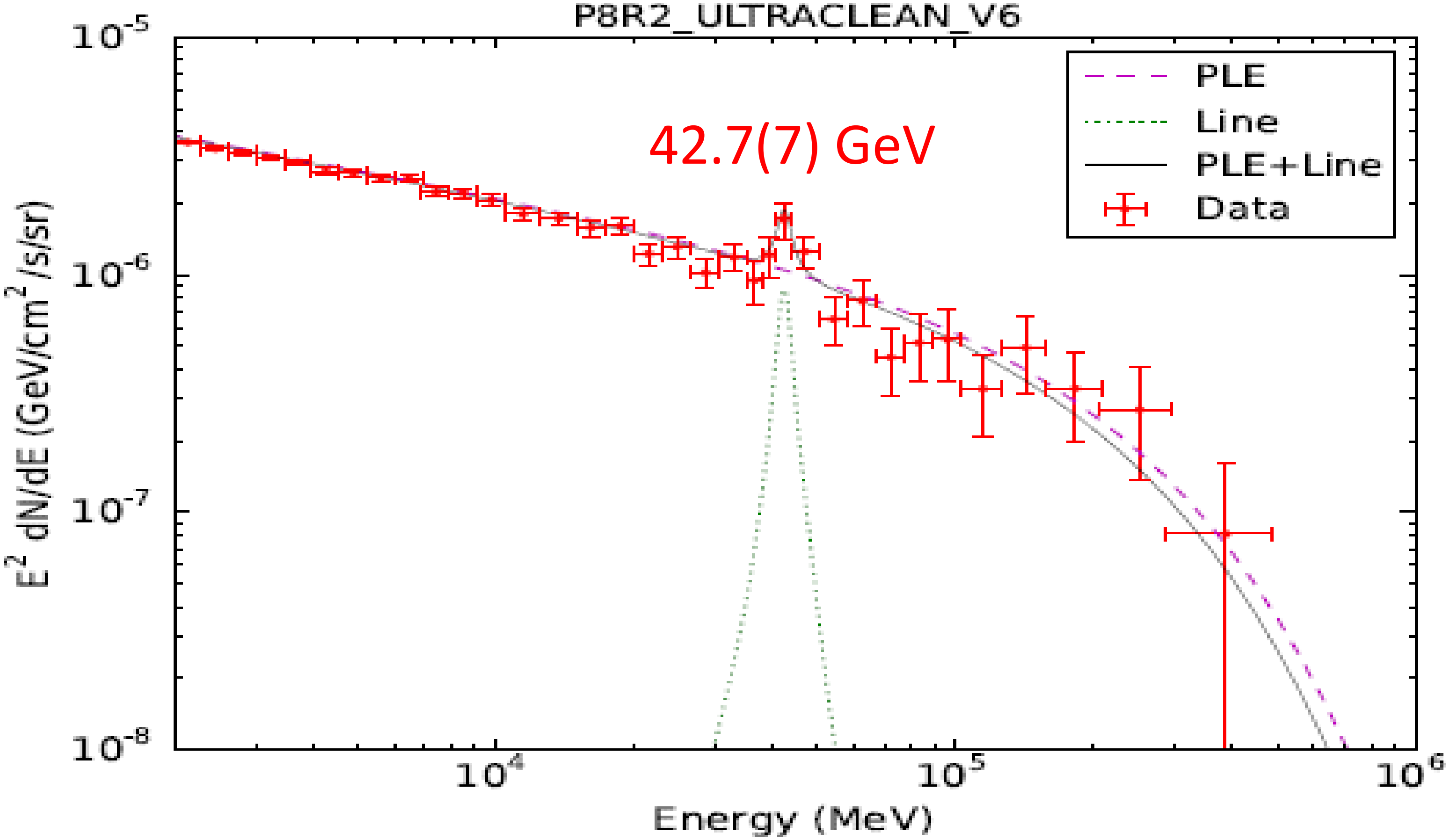
The 3.57 (2) keV peak was identified in a stacked XMM-Newton MOS and PN x-ray spectrum.

E. Bulbul et al., Astrophys. J. 789, 13 (2014).

The 3.57 keV peak is proposed as the B1 annihilation peak.

Then, the rest mass of the B1 particle is 3.57(2) keV/c^2.

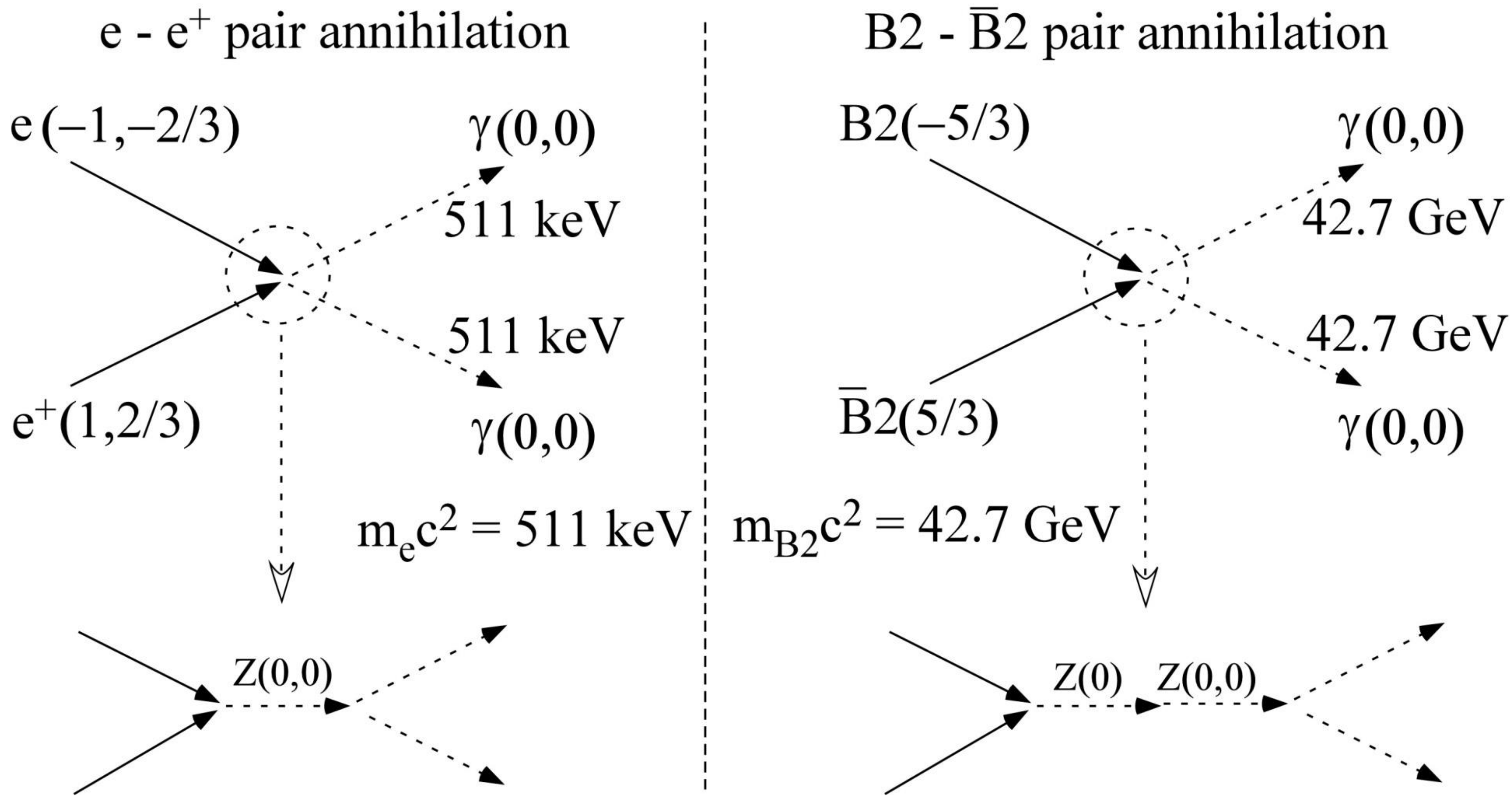
B2 fermionic dark matter measurements



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. Liangl et al., Phys. Rev. D 93, 103525 (2016).

The 42.7 GeV peak is proposed as the B2 annihilation peak. Then, the rest mass of the B2 particle is 42.7(7) GeV/c^2.

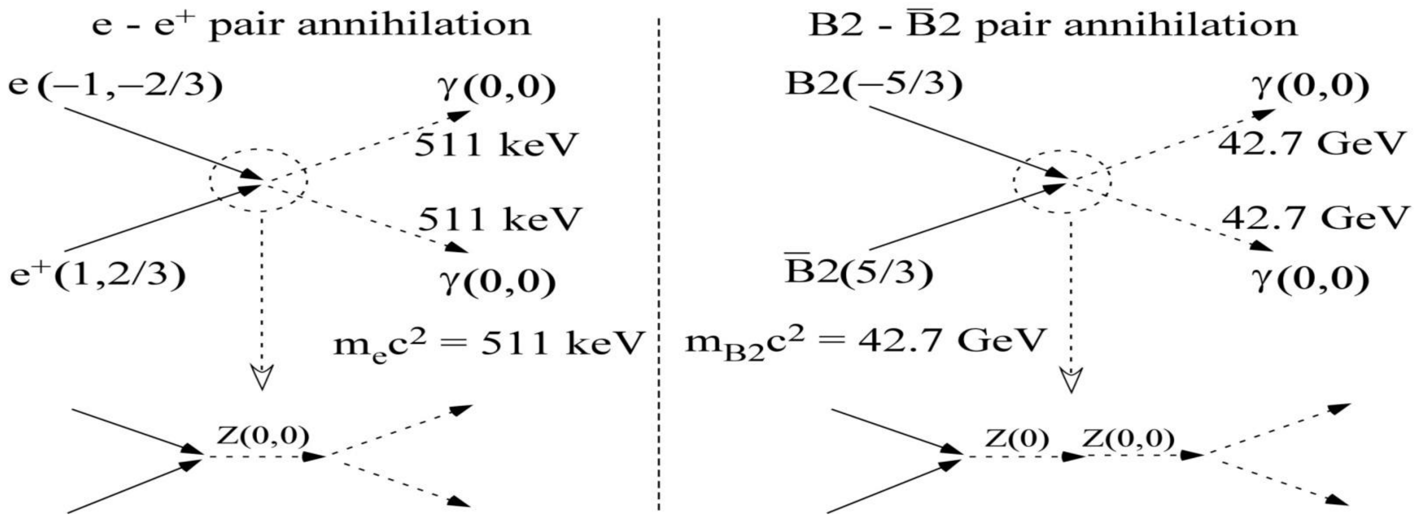


The 42.7(7) GeV peak was identified in the gamma-ray spectrum from the Fermi Large Area Telescope (LAT) in the directions of 16 massive nearby Galaxy Clusters.

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

The 42.7 GeV peak is proposed as the B2 annihilation peak. Then, the rest mass of the B2 particle is 42.7(7) GeV/c^2.

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.

From the galaxy observations

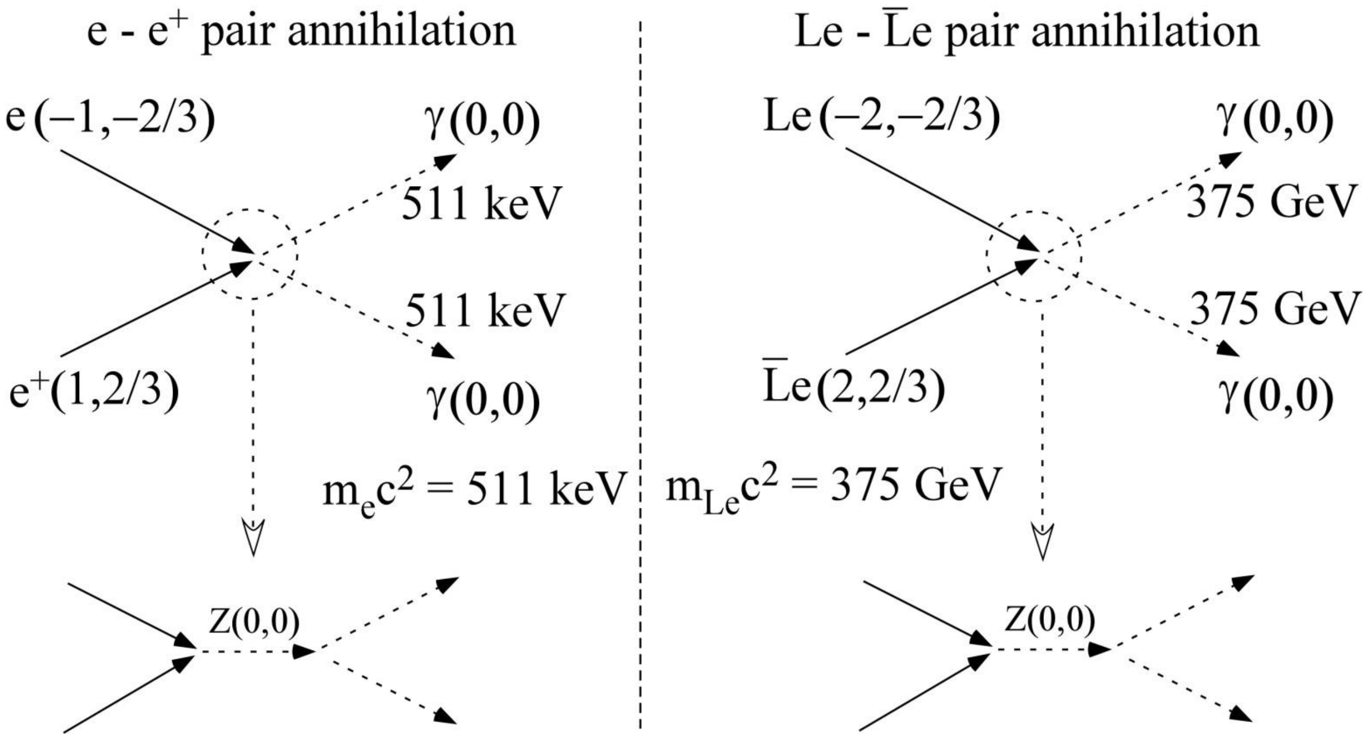
Y.F. Liangl et al., Phys. Rev. D 93, 103525 (2016).

From the constraints on the mass and couplings of a fermionic dark matter candidate that annihilates through the Z boson, the only currently allowed range of the fermionic dark matter rest mass is 40 – 48 GeV/c^2. The experiments of XENON1T are expected in the near future.

Miguel Escudero et al., arXiv: 1609.09079 (Sep. 28, 2016).

XENON1T: E. Aprile et al., JCAP 04, 027 (2016).

From the earth experiments



$$\text{Le} \longrightarrow e^- + e^- + \bar{\upsilon}_e$$

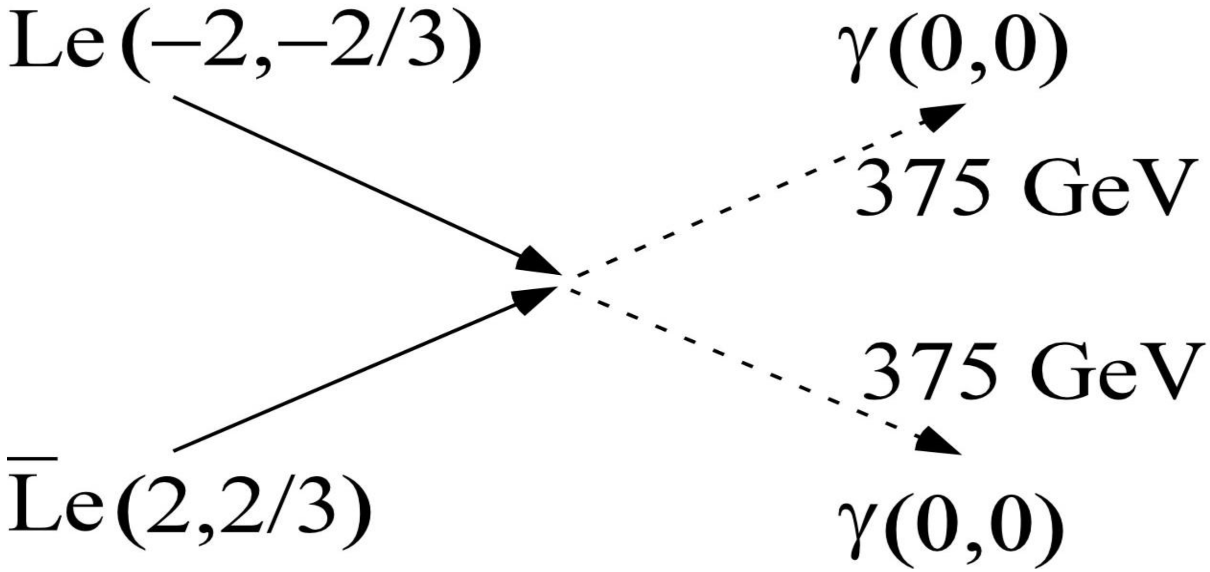
(-2,-2/3) (-1,-2/3) (-1,-2/3) (0,2/3)

$$\text{Le} + \overline{\text{Le}} \longrightarrow \gamma + \gamma$$

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

(EC,LC): (-2,-2/3)

Le - $\overline{\text{L}}$e pair annihilation



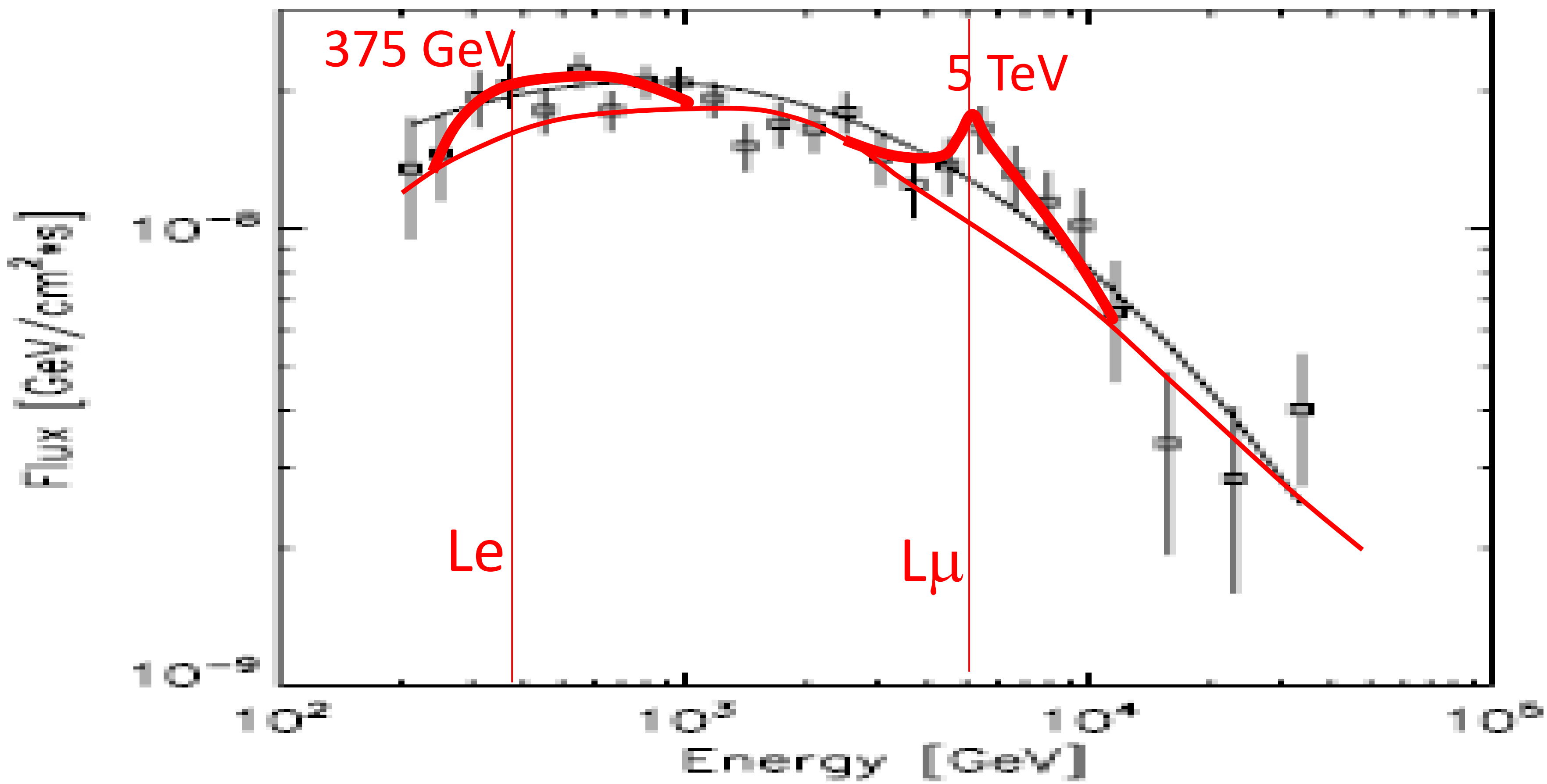
Heavy lepton pair annihilation at galaxies

1) gamma(375 GeV) peak

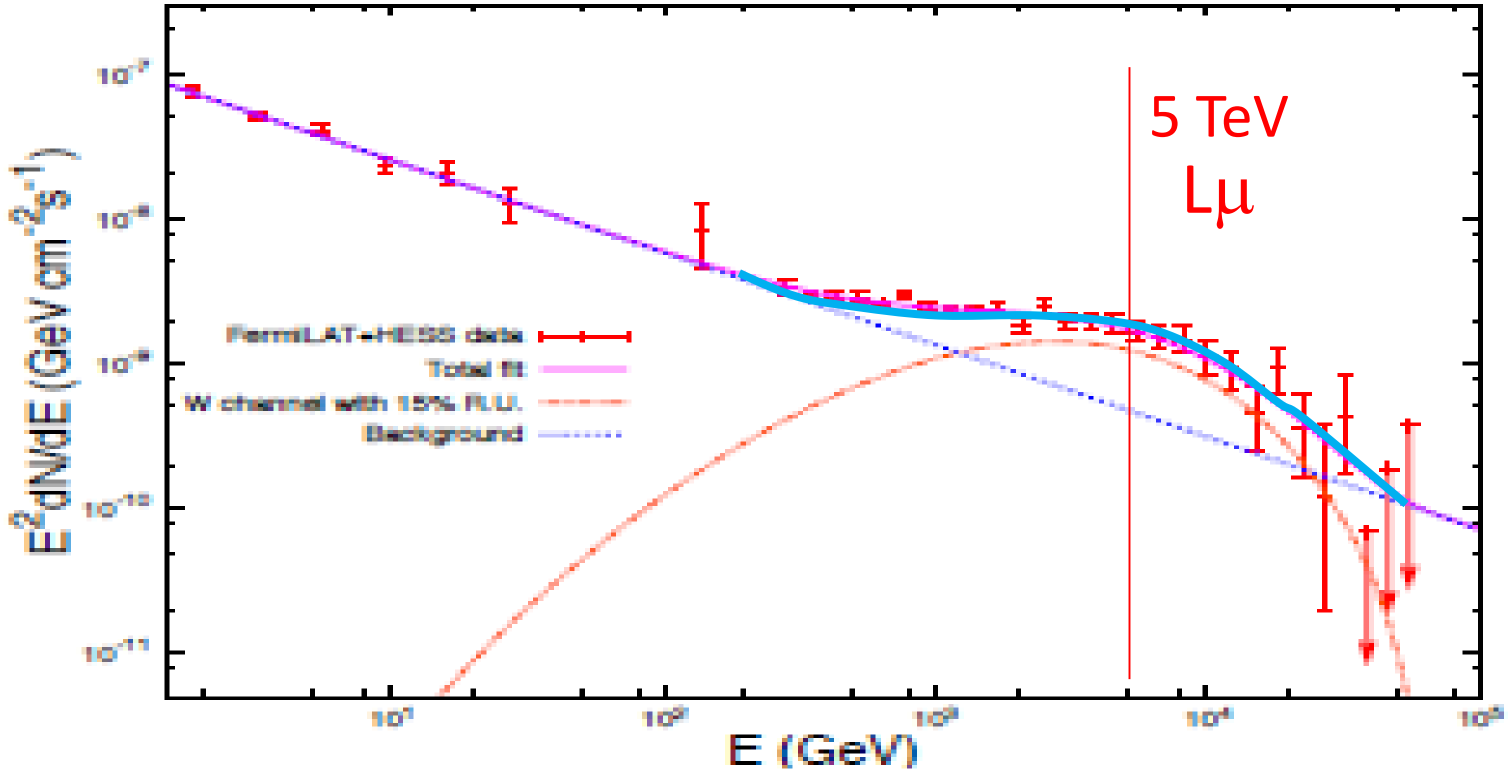
2) electron + gamma(375 GeV) → electron (375 GeV) photo-electric peak

3) positron + gamma (375 GeV) → positron (375 GeV) photo-electric peak

Lμ – anti Lμ annihilation peak at 5 TeV
Le – anti Le annihilation peak at 375 GeV.



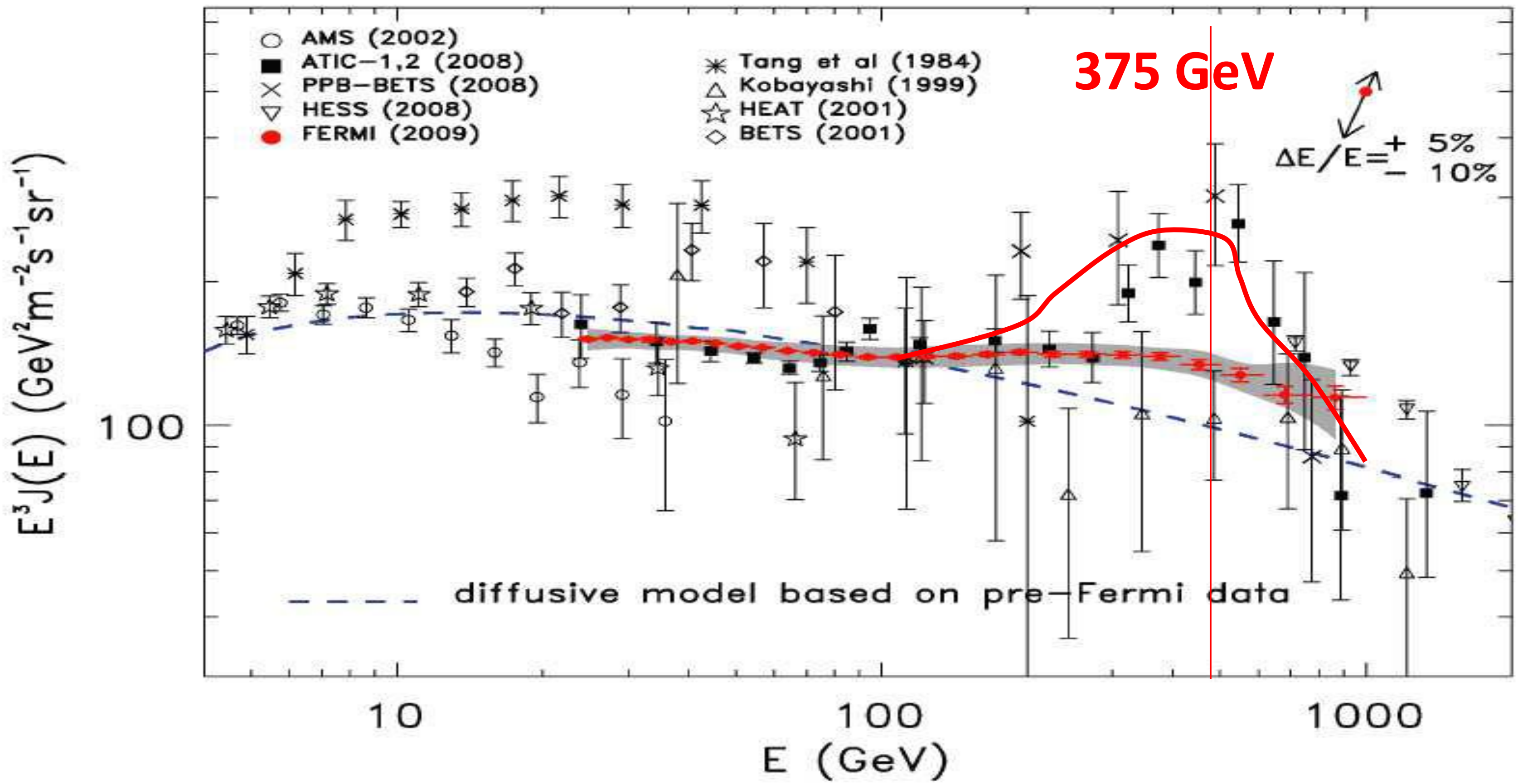
TeV gamma ray spectrum from RX J1713.7-3946 with HESS.
C.Y. Huang et al., Astroparticle Physics 27, 429 (2007).



V. Gammaldi, arXiv: 1412.7639 (2014).

TeV gamma ray spectrum from RX J1713.7-3946 with HESS and Fermi-LAT data.

Lμ – anti Lμ annihilation peak at 5 TeV

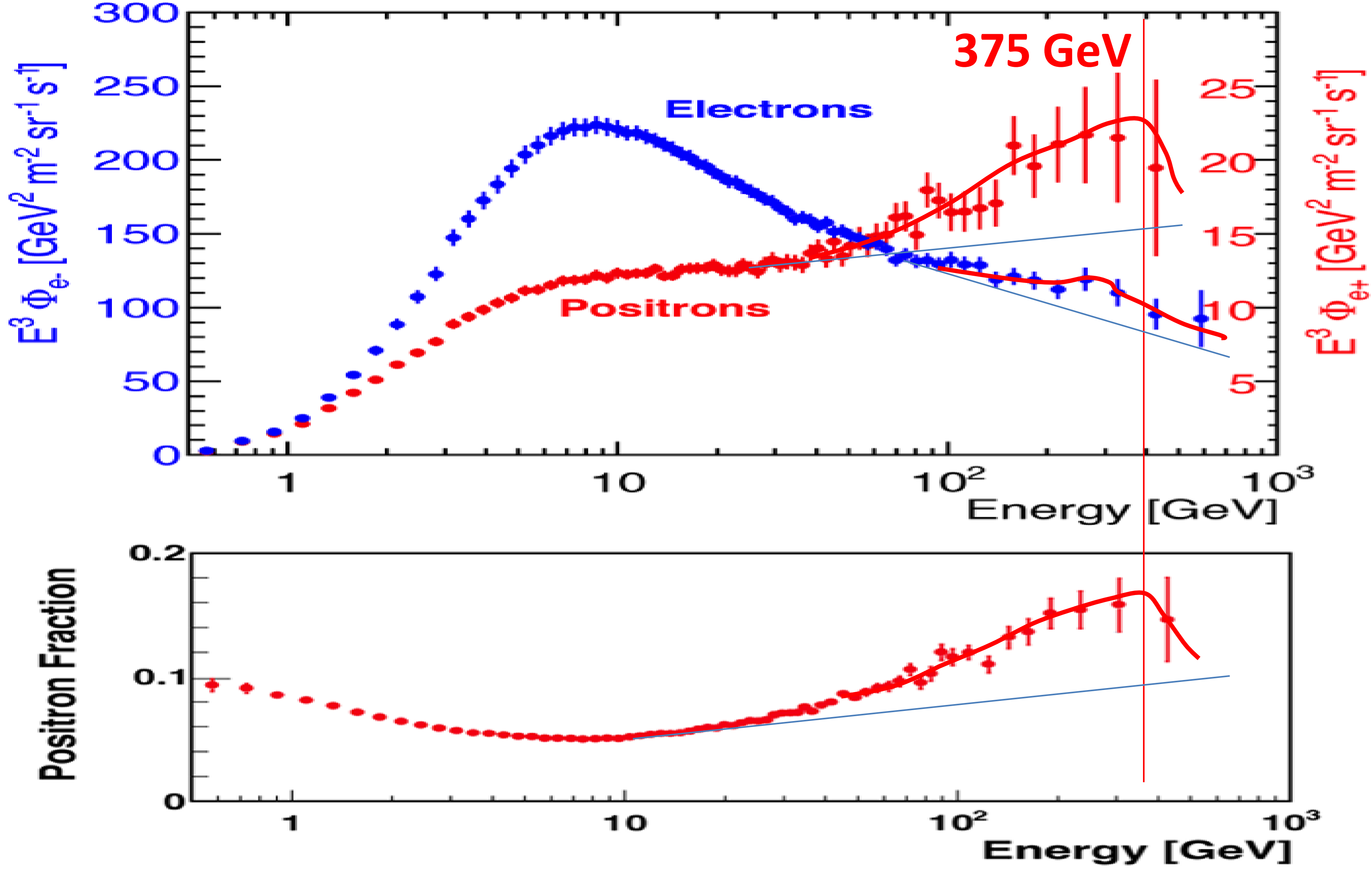


Cosmic electron spectra

A. Abdo et al., Phys. Rev. Lett. 102, 181101 (2009).

Heavy lepton pair annihilation at galaxies

electron + gamma(375 GeV) → electron (375 GeV) photo-electric peak



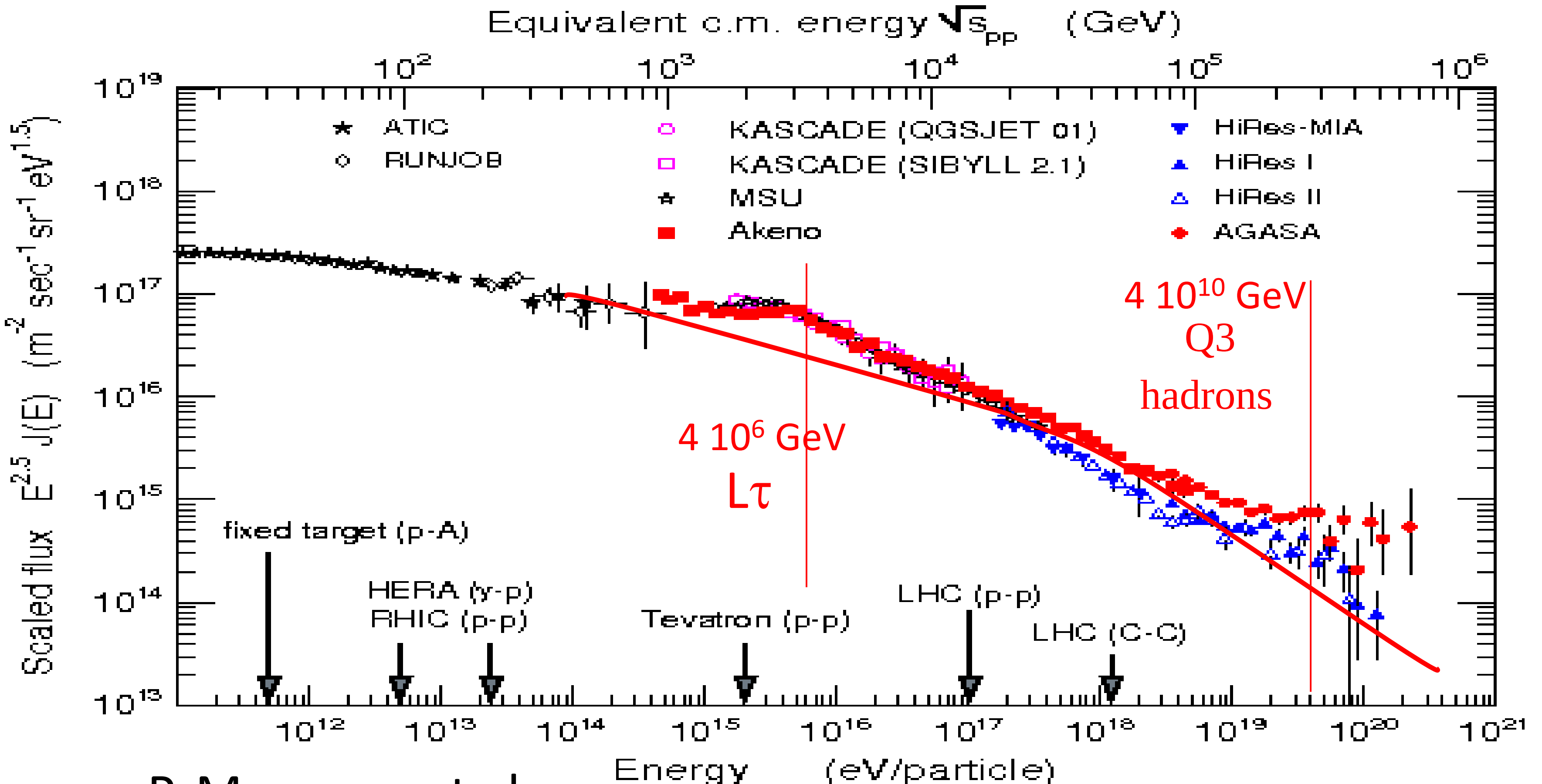
Positron anomaly; AMS-02

L. Accardo et al., Phys. Rev. Lett. 113, 121101 (2014).

M. Aguilar et al., Phys. Rev. Lett. 113, 121102 (2014)

M. Aguilar et al., Phys. Rev. Lett. 110, 141102 (2013).

Q3 hadrons: Hadrons including the Q3 quark.



P. Meszaros et al.,
www2.astro.psu.edu/users/nnp/cr.html.

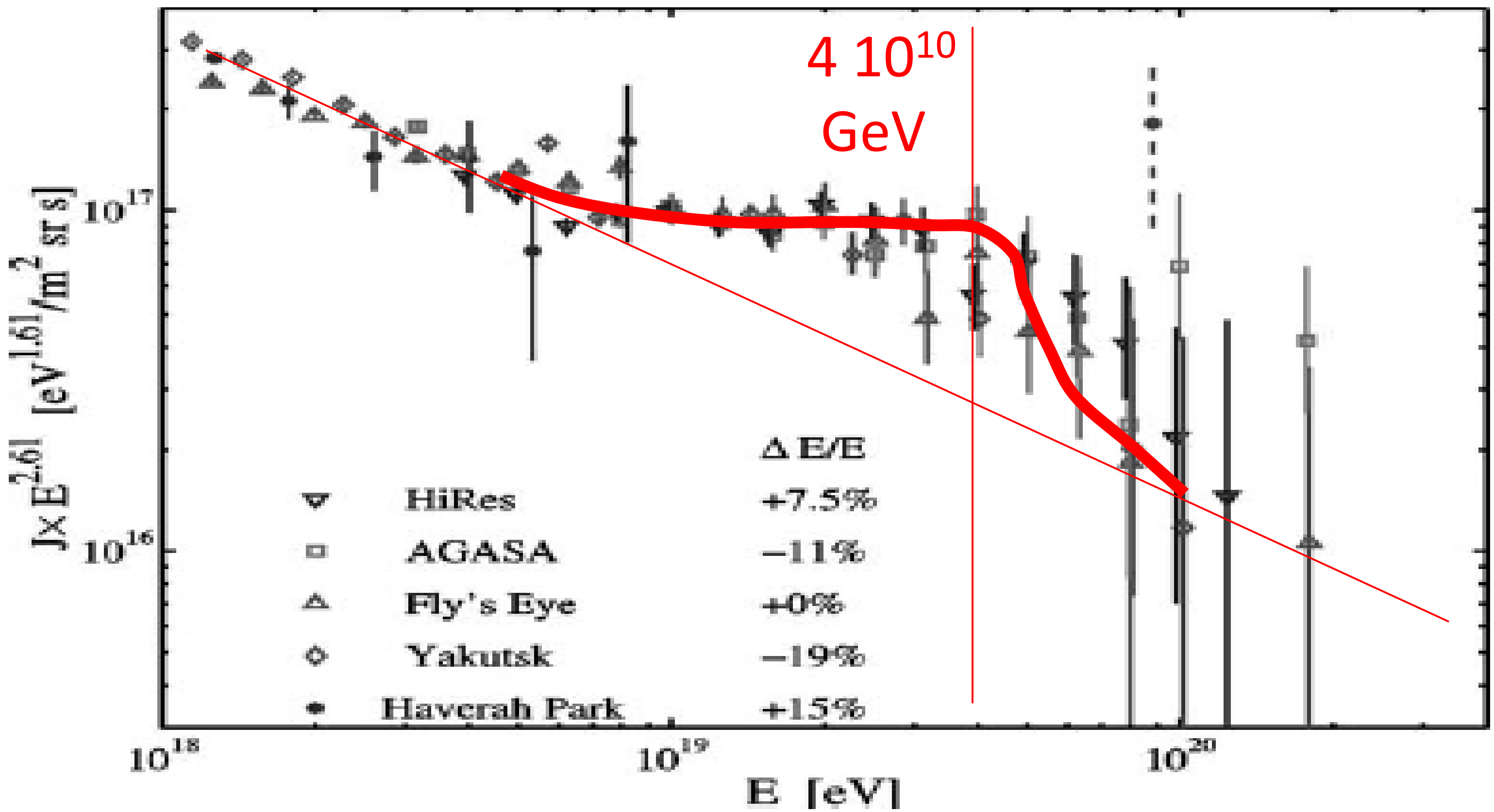
Ultra-high energy cosmic ray spectra

Lτ – anti Lτ annihilation peak at 4 10^6 GeV

Q3 hadron – Q3 anti hadron annihilation peak at 4 10^{10} GeV.

Q3 might have the rest mass of ~ $10^{7\text{-}10}$ GeV/c^2.

Q3 hadrons



J.N. Bahcall and E. Waxman, Phys. Lett. B556, 1 (2003). Ultra-high energy cosmic ray spectra after adjusting the energy calibrations of the different data.

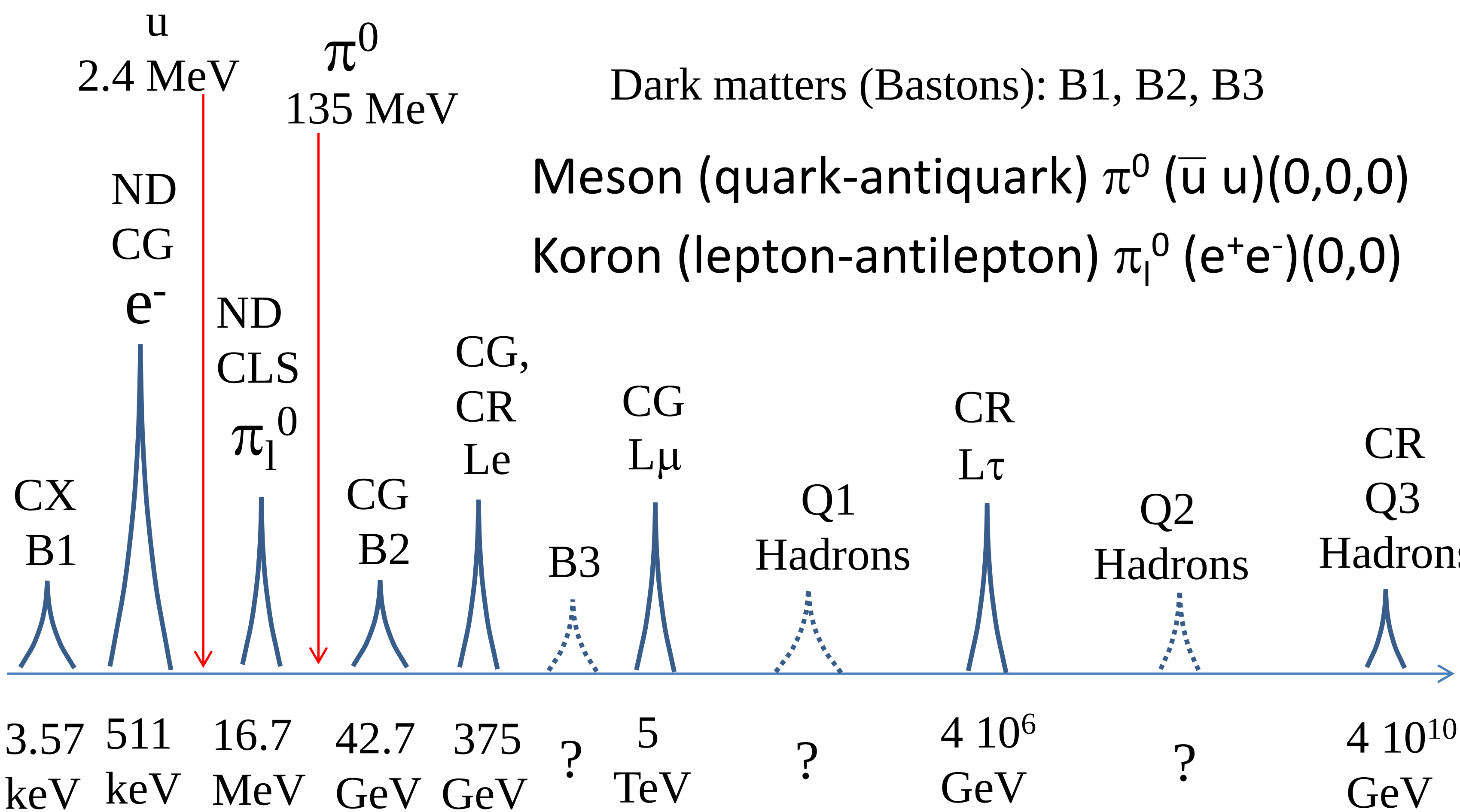
Q3 hadron – Q3 anti hadron annihilation peak at 4 10^{10} GeV.

(2) Possible searches from astronomical observations

Dark matters (Bastons): B1, B2, B3

Meson (quark-antiquark) π^0 ($\bar{u}$ u)(0,0,0)

Koron (lepton-antilepton) π_l^0 (e^+e^-)(0,0)



unit: $E=mc^2$

ND: Nuclear Decay, CLS: Cosmic Light Spectroscopy

NR: Nuclear Reaction

CG: Cosmic Gamma ray, CX: Cosmic X ray

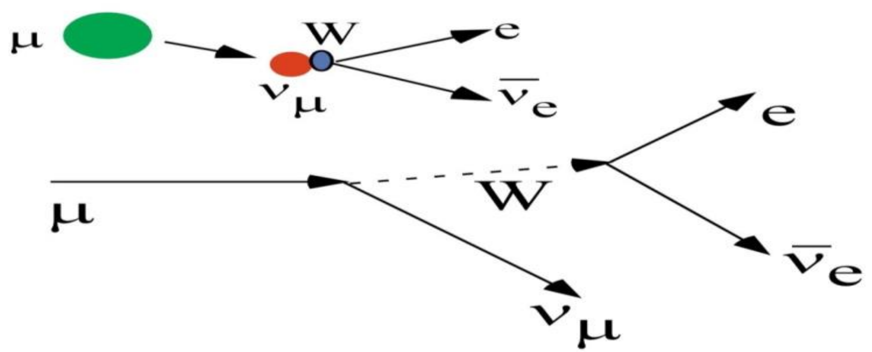
CR: Cosmic ray

Rest masses of B1, B2, Le, Lμ, Lτ, Q3 are tentatively assigned for the further researches.

Several examples of decays and reactions

$$\mu \longrightarrow \nu_\mu + e + \bar{\nu}_e$$

$$(-1,\ -5/3) = (0, -5/3) + (-1,\ -2/3) + (0,\ +2/3)$$

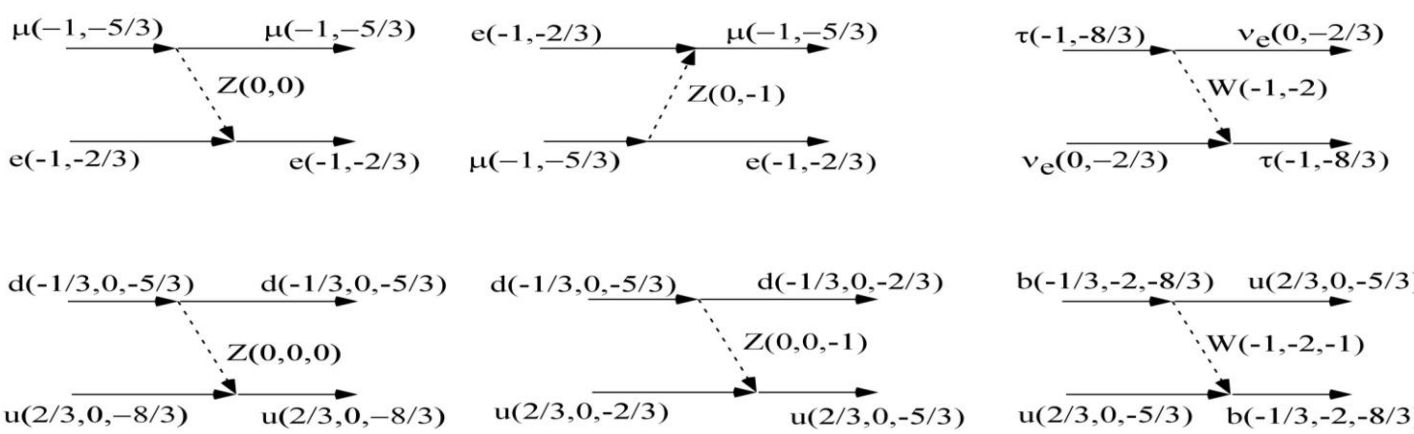


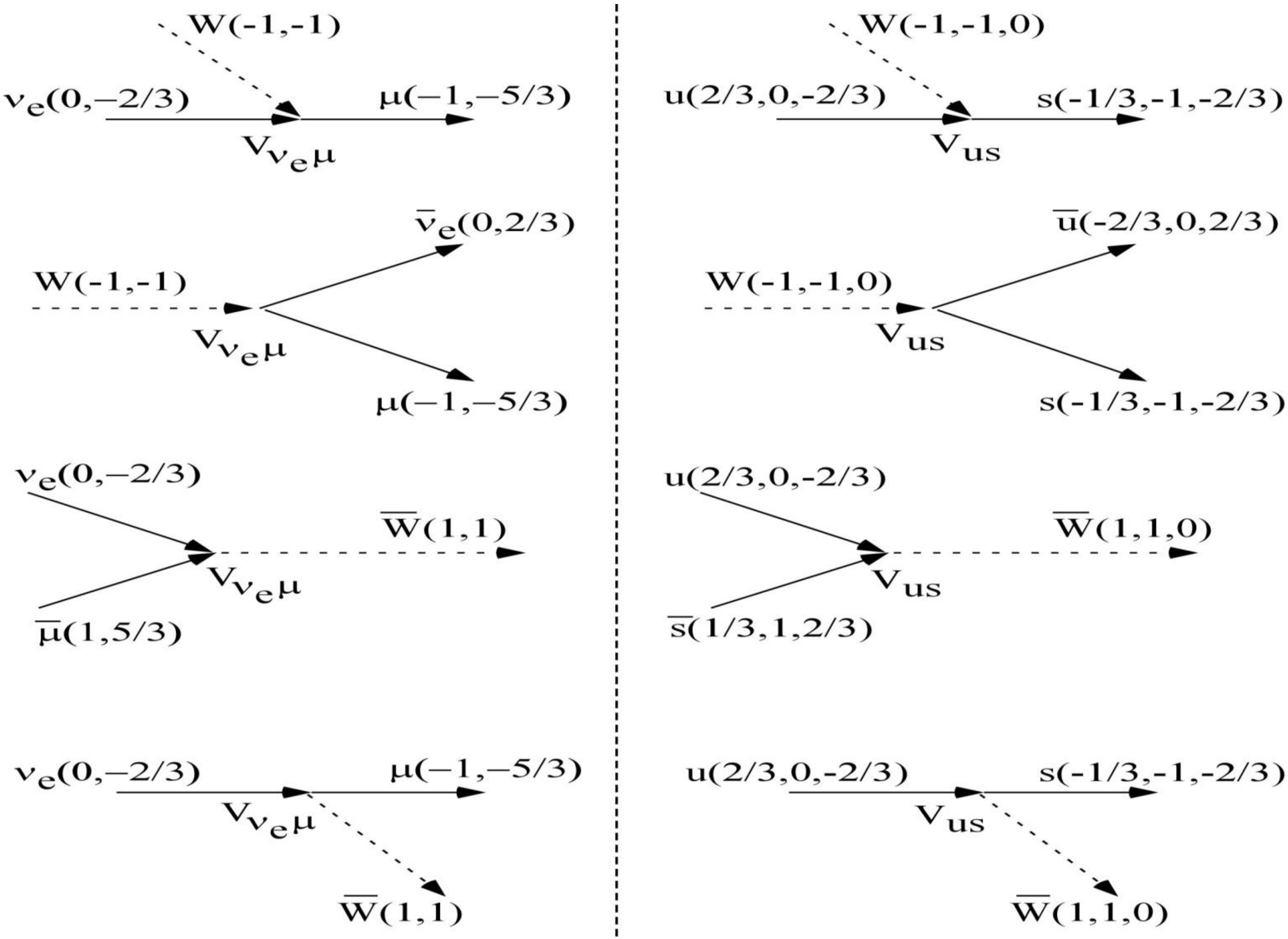
$$\mu \longrightarrow W + \nu_\mu$$

$$(-1,\ -5/3) = (-1,\ 0) + (0,\ -5/3)$$

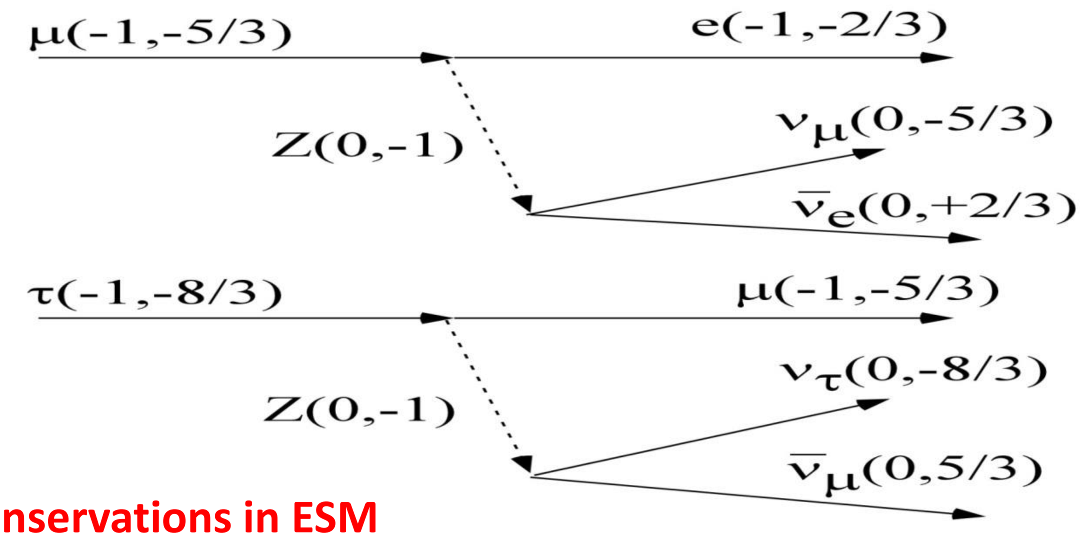
$$W \longrightarrow e + \bar{\nu}_e$$

$$(-1,\ 0) = (-1,\ -2/3) + (0,\ +2/3)$$

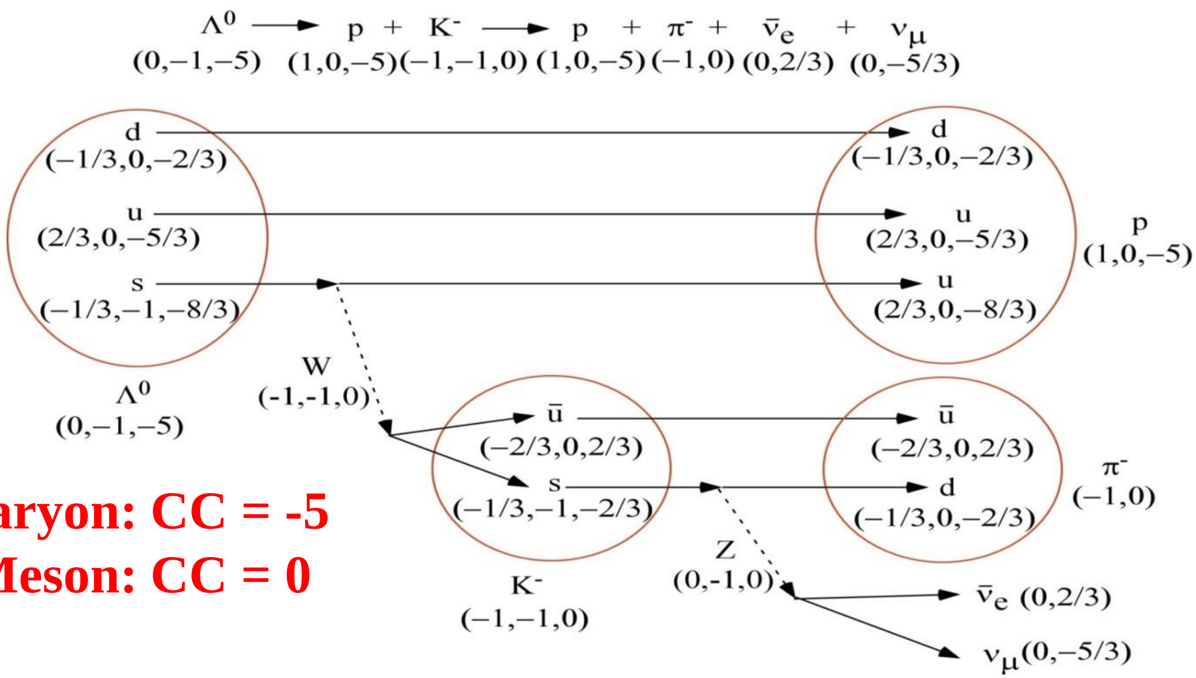




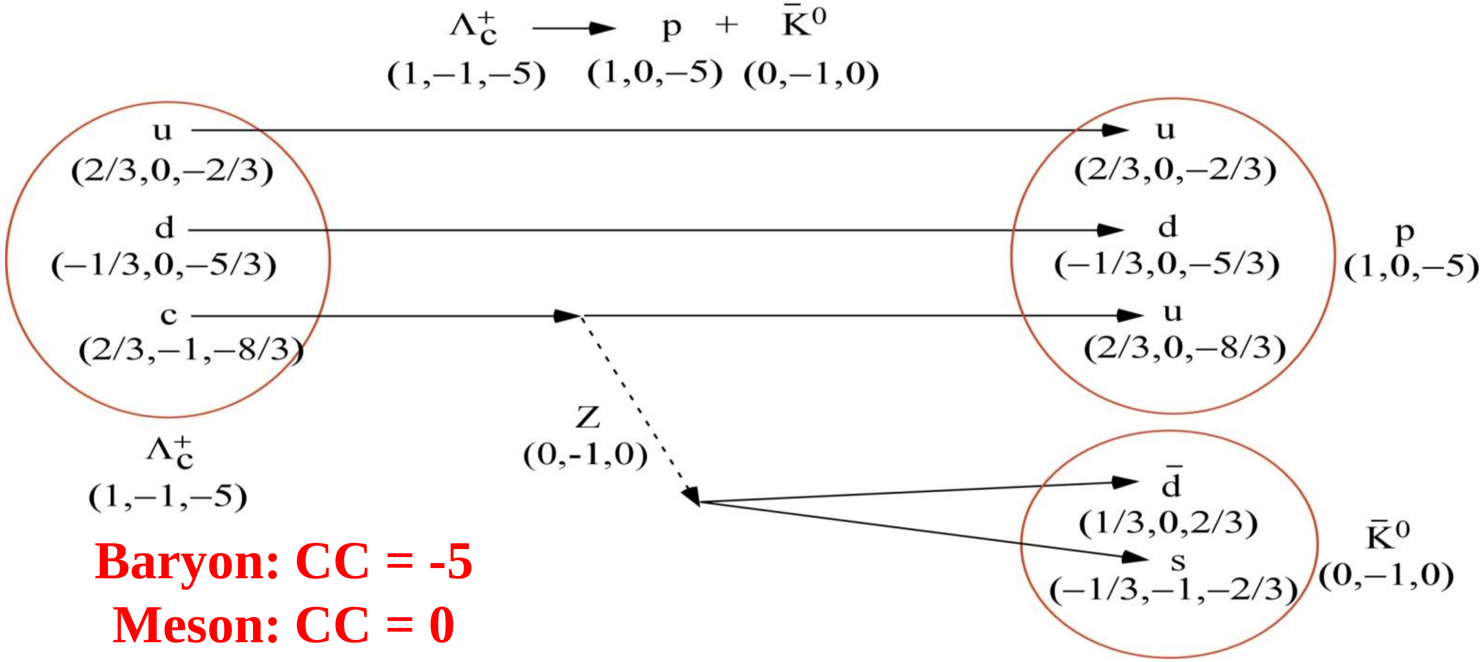
Lepton matrix element ($V\nu_e\mu$) is compared with the quark matrix element (V_{us}).



EC,LC,CC: Conservations in ESM



Baryon: CC = -5
Meson: CC = 0



Baryon: CC = -5

Meson: CC = 0

EC,LC,CC: Conservations in ESM

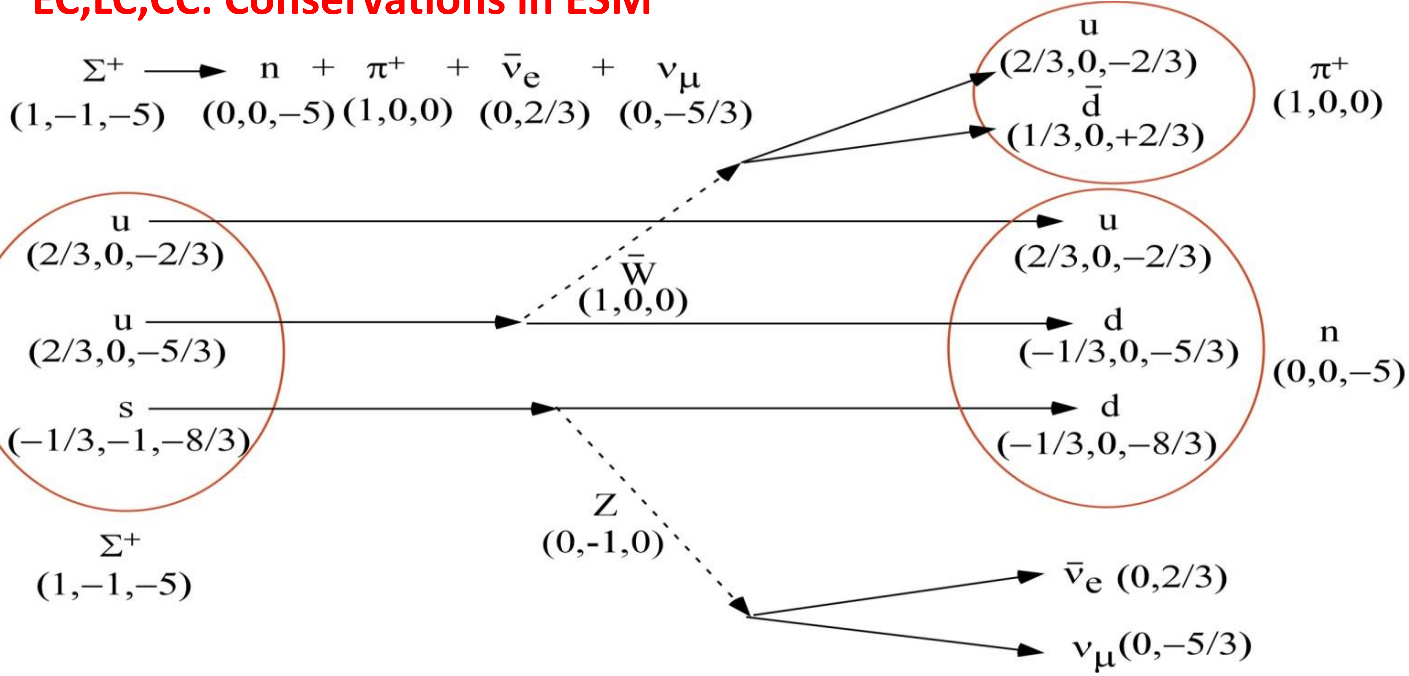


Table 3. Electric charges (EC), lepton charges (LC) and color charges (CC) for the elementary fermion particles. Red colored ones have been previously known. All charges are normalized to ECs of e (EC=-1) and ν_e (EC=0). u(r) = (2/3.0,-2/3)=(EC,LC,CC).

EC flavor	x1x2x3	x1x2x3	x1x2x3
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 EC	-5	-3	-1
LC flavor		x4x5x6	x4x5x6
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 LC		-5	-3
CC flavor			x7x8x9
x7			-2/3(r)
x8			-5/3(g)
x9			-8/3(b)
Total CC			-5

Bastons, (Dark matters) | Leptons, | Quarks

Possible rest masses of B1, B2, Le, Lμ, Lτ, Q3 are 3.57(2) keV/c^2, 42.7(7) GeV/c^2, 375 GeV/c^2, 5 TeV/c^2, 4 10^6 GeV/c^2 and ~ 4 10^{7-10} GeV/c^2, respectively.

Gravitational force: graviton (charge independent): g(0) $\leftrightarrow$ g(0,0) $\leftrightarrow$ g(0,0,0)

Electromagnetic force: photon (charge dependent):

$\gamma(0) \not\leftrightarrow \gamma(0,0) \not\leftrightarrow \gamma(0,0,0)$

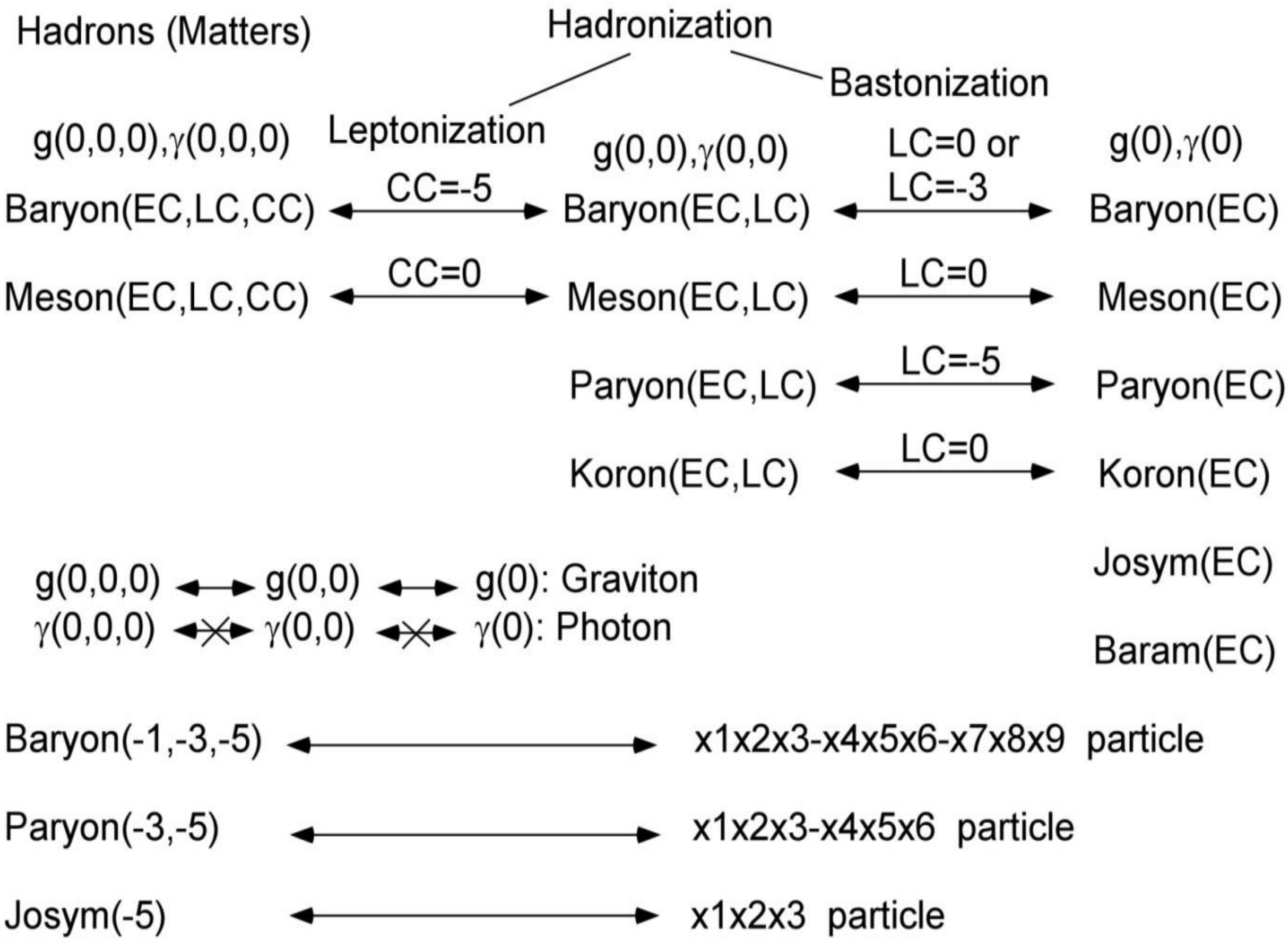
Gluons are replaced with these bosons.

EC flavor	x1x2x3	x1x2x3	x1x2x3
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 EC	-3	-3	-3
LC flavor		x4x5x6	x4x5x6
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(–2,–1)	-1 Z(0,-1),W(-1,-1),Y(-2,-1)
x6		-2 Z(0,–2),W(–1,–2),Y(–2,–2)	-2 Z(0,-2),W(-1,-2),Y(-2,-2)
Total LC		-3	-3
CC flavor			x7x8x9
x7			0 CC(0)
x8			-1 CC(-1)
x9			-2 CC(-2)
Total CC			-3

Dark matter force, Weak force, Strong force

Particles

- Background fluctuation bosons (s=0,1,2) (zero charges, xi-xj):
  - photon (s =1, m=0),
  - graviton (s =2, m=2.1248 10^{-31} eV/c2),
  - b(baedal or bumo) - boson (s =0,1, E_b=8.1365 $10^{38} x^2$ (eV)(x:m))
- Elementary particles
  - 39 Fermions (s =1/2)
    - Quark (xi-xj-xk) (3x3x3=27) (EC,LC,CC)
    - Lepton (xi-xj) (3x3=9) (EC,LC)
    - Baston (xi) (3) (EC)
  - 39 Bosons (s =1)
    - Z/W/Y (xi-xj-xk) (3x3x3=27) (EC,LC,CC)
    - Z/W/Y (xi-xj) (3x3=9) (EC,LC)
    - Z/W/Y (xi) (3) (EC)
- Hadrons (xi-xj-xk) (EC,LC,CC)
  - Baryon (3 quarks) CC = -5
  - Meson (quark-antiquark) CC = 0
- Hadrons (xi-xj) (EC,LC)
  - Paryon (3 leptons) LC = -5
  - Koron (lepton-antilepton) LC = 0
- Hadrons (xi) (EC)
  - Josym (3 bastons) EC = -5
  - Baram (baston-antibaston) EC = 0



Hadrons (Matters)
Hadronization
Leptonization
Bastonization
g(0,0,0),γ(0,0,0)
g(0,0),γ(0,0)
g(0),γ(0)
Baryon(EC,LC,CC)
CC=-5
Baryon(EC,LC)
LC=0 or
LC=-3
Baryon(EC)
Meson(EC,LC,CC)
CC=0
Meson(EC,LC)
LC=0
Meson(EC)
Paryon(EC,LC)
LC=-5
Paryon(EC)
Koron(EC,LC)
LC=0
Koron(EC)
Josym(EC)
Baram(EC)
g(0,0,0)
g(0,0)
g(0): Graviton
γ(0,0,0)
γ(0,0)
γ(0): Photon
Baryon(-1,-3,-5)
x1x2x3-x4x5x6-x7x8x9 particle
Paryon(-3,-5)
x1x2x3-x4x5x6 particle
Josym(-5)
x1x2x3 particle

Summary

- Three-dimensional quantized space model: New extended standard model.
- Three generations of the leptons and quarks correspond to the lepton charges.
- Quarks have three charges of EC, LC and CC, and leptons have two charges of EC and LC.
- New particles of bastons have only one charge of EC and are the dark matters.
- The dark matter force is introduced with the new Z/W/Y(EC) bosons.
- The gluons are replaced with the new Z/W/Y(EC,LC,CC) bosons.
- Proton decay is Impossible
- Neutrinos are not Majorana particles because of the non-zero lepton charges.
- X(16.70(35) MeV) peak with the spin of 1^+ is proposed as the first Koron of π_l^0 (e^+e^-)(0,0) observed experimentally.

  Meson (quark-antiquark) π^0 ($\underline{u}$ u)(0,0,0)

  Koron (lepton-antilepton) π_l^0 (e^+e^-)(0,0)
- π_l^0 (e^+e^-) is the good candidate of the neutral boson (X) for the lithium problem.
- Dark matters (Bastons) are interacting with the leptons and hadrons by the gravitational force.
- Z and W^- boson in standard model are Z(0,0) and W(-1,0) in the present work, respectively.
- Dark matter force, weak force and strong force are explained consistently.
- Possible rest masses of B1, B2, Le, Lμ, Lτ, Q3 are 3.57 keV/c^2, 42.7(7) GeV/c2, 375 GeV/c^2, 5 TeV/c^2, 4 10^6 GeV/c^2 and 4 10^{7-10} GeV/c^2, respectively.
- 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.

- See, for more details, the papers of
- “Dark matters, proton radius problem, cosmic lithium problem, elementary particles and new extended standard model”,
- “Elementary Particles, dark matter candidate and new extended standard model”, and
- “Three-dimensional quantized spaces, universe, elementary particles, quantum mechanics, general relativity theory and dark matters”
- which can be found in

https://www.researchgate.net/profile/J_Hwang2 .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New physics model proposed, for the first time, by myself.

Journey into the universe

Three-dimensional quantized spaces, elemetary particles, quantum mechanics, general relativity theory, dark matters and dark energy

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Full paper to be downloaded;

JJJPL report 20160101-1 (2016).
researchgate.net; DOI:10.13140/RG.2.1.2388.4561.
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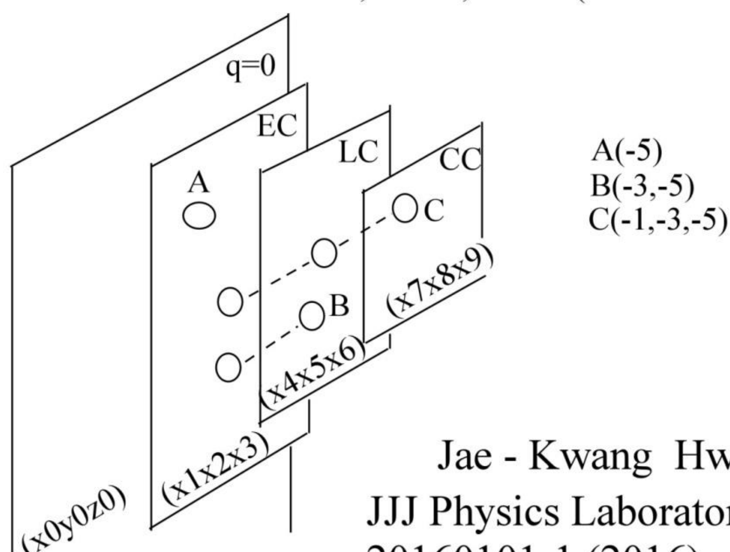
Journey into the universe

Three-dimensional quantized spaces, elementary particles and quantum mechanics

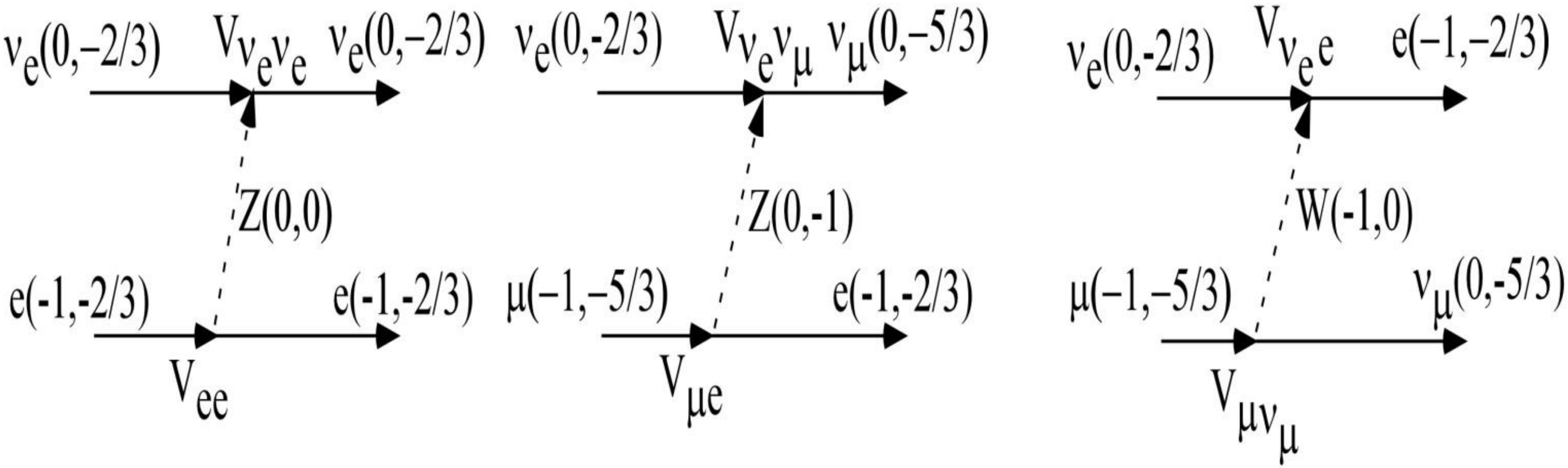
Mother universe
(x0y0z0) space with the infinite space-time range
q = 0, E=infinite, P_t : not defined, P_x : not defined

Daughter universes
(x1x2x3), (x4x5x6), (x7x8x9) spaces with the quantum time of t_q
q = 0 (flat space) or q ≠ 0 (warped space)
P_t = E/c > 0, P_x ≠ 0 (non-zero positive energy): Finite space range

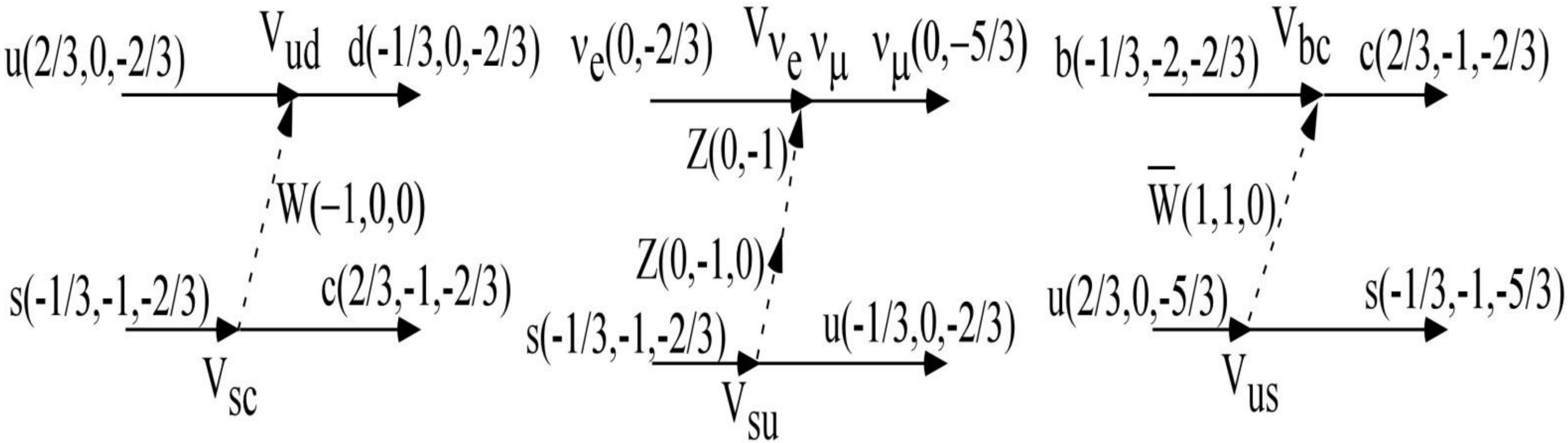
Matters (q < 0) with E>0:
A: x1x2x3 minimum warped quantum: EC = -5 (3 bastons)
B: x1x2x3-x4x5x6 minimum warped quantum: EC=-3, LC=-5
(3x3=9 leptons)
C: x1x2x3-x4x5x6-x7x8x9 minimum warped quantum:
EC=-1, LC=-3, CC=-5 (3x3x3 = 27 quarks)



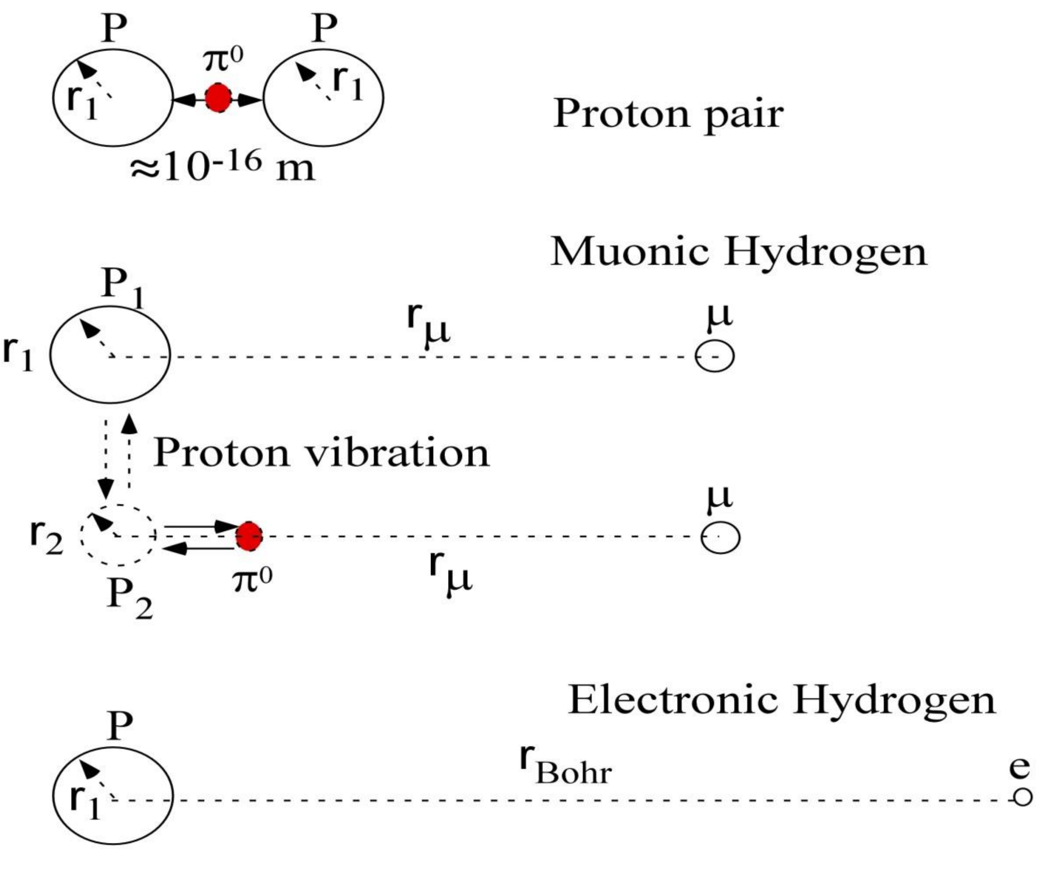
Jae - Kwang Hwang,
JJJ Physics Laboratory report,
20160101-1 (2016)



EC,LC,CC: Conservations in ESM



Proton charge radius problem



$E_p = 938.27\ 10^6$ eV, $r_1 = 0.8768(69)\ 10^{-15}$ m

$E_\pi = 135\ 10^6$ eV, $E_1 = E_p = E_2 + E_\pi$

$E_{p\mu} = (E_1 + E_2)/2 = E_p - E_\pi/2 = 870.77\ 10^6$ eV

$r_{p\mu} = 0.84184(67)\ 10^{-15}$ m

$r_2 < r_{p\mu} < r_1$, Here, $E = mc^2$.

$r_\mu = (E_e / E_\pi)\ r_{Bohr}$

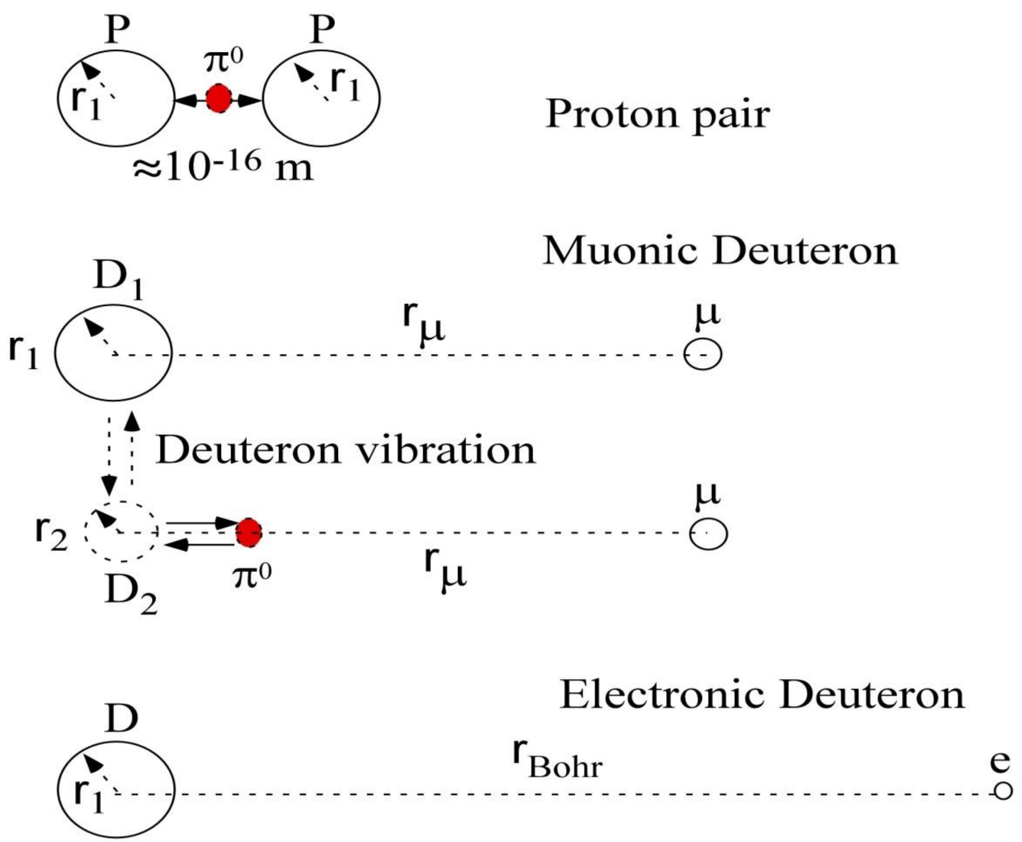
The calculated average proton radius ($r_{p\mu}$) is $0.84467\ 10^{-15}$ m from the equation of $E_p = 12.2047\ 10^{38}\ r_p^2$ (eV, m) and $0.8552\ 10^{-15}$ m from the equation of $E_p = 1.3920\ 10^{54}\ r_p^3$ (eV, m). The experimental proton radius ($r_{p\mu}$) is $0.84184(67)\ 10^{-15}$ m and $0.84087(39)\ 10^{-15}$ m.

R. Pohl et al., Nature 466, 213 (2010).

The proton charge radius problem is explained by using the proton vibration. The proton vibration repeats the emitting and absorbing process of the π^0 meson. The proton vibration takes place in the muonic hydrogen but not in the electronic hydrogen because the muon is much closer to the proton than the electron. The distance of the electron from the proton is $r_{Bohr} = 5.29\ 10^{-11}$ m and the distance of the muon from the proton is $r_\mu = 2.557\ 10^{-13}$ m. Under this proposition, the average proton radius ($r_{p\mu}$) can be calculated from the average proton energy ($E_{p\mu}$). The proton energy ($E_p = mc^2 = 938.27\ 10^6$ eV) is related to the proton radius by two equations of $E_p = 12.2047\ 10^{38}\ r_p^{\ 2}$ (eV, m) and $E_p = 1.3920\ 10^{54}\ r_p^{\ 3}$ (eV, m) where r_p is 0.8768(69) 10^{-15} m [3]. The obtained average proton energy ($E_{p\mu}$) is 870.77 10^6 eV. Then the calculated average proton radius ($r_{p\mu}$) is 0.84467 10^{-15} m from the equation of $E_p = 12.2047\ 10^{38}\ r_p^{\ 2}$ (eV, m) and 0.8552 10^{-15} m from the equation of $E_p = 1.3920\ 10^{54}\ r_p^{\ 3}$ (eV, m). The experimental proton radius ($r_{p\mu}$) is 0.84184(67) 10^{-15} m [4] and 0.84087(39) 10^{-15} m [5]. The calculated average proton radii of 0.84467 10^{-15} m and 0.8552 10^{-15} m are consistent with the experimental proton radii of 0.84184(67) 10^{-15} m and 0.84087(39) 10^{-15} m. Therefore, the proton charge radius problem can be explained by using the proton vibration connected with the π^0 meson.

[3] P.J. More et al., Review of Mod. Phys. **80**, 633 (2008).
[4] R. Pohl et al., Nature **466**, 213 (2010).
[5] A. Antognini et al., Science **339**, 417 (2013).

Deuteron charge radius problem



$E_D = 1875.6\ 10^6$ eV, $r_1 = 2.1424(21)\ 10^{-15}$ m

$E_\pi = 135\ 10^6$ eV, $E_1 = E_D = E_2 + E_\pi$

$E_{D\mu} = (E_1 + E_2)/2 = E_D - E_\pi/2 = 1808.1\ 10^6$ eV

$r_{D\mu} = 2.12562(78)\ 10^{-15}$ m

$r_2 < r_{D\mu} < r_1$, Here, $E = mc^2$.

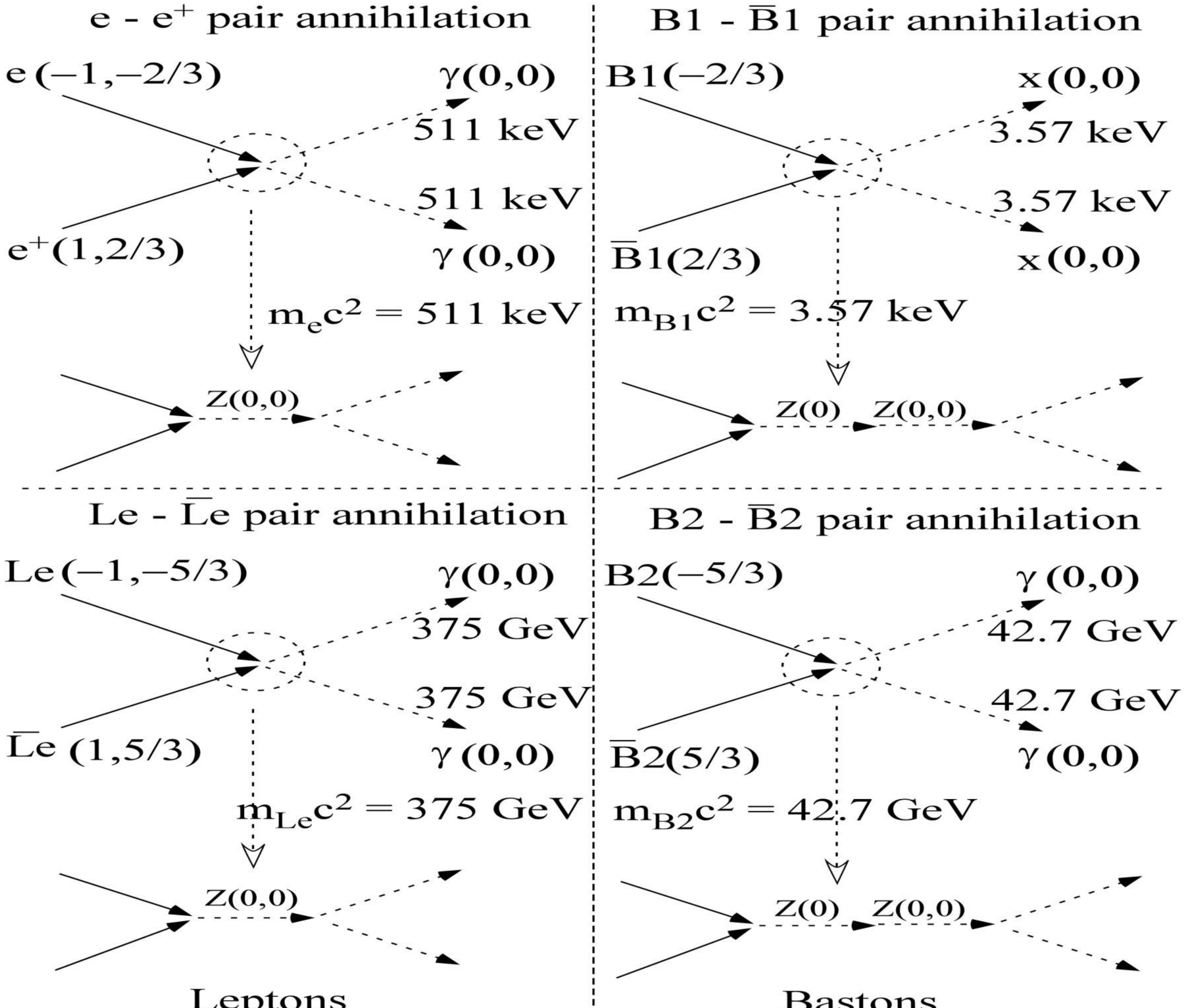
$r_\mu = (E_e / E_\pi)\ r_{Bohr}$

The calculated average deuteron radius ($r_{D\mu}$) is 2.11632 10^{-15} m from the equation of $E_D = 1.9074\ 10^{53}\ r_D^3$ (eV, m) and 2.10349 10^{-15} m from the equation of $E_p = 4.0864\ 10^{38}\ r_D^2$ (eV, m). The experimental deuteron radius ($r_{D\mu}$) is 2.12562(78) 10^{-15} m.

R. Pohl et al., Science 353, 669 (2016).

The deuteron charge radius problem [6] is explained by using the deuteron vibration. The deuteron vibration repeats the emitting and absorbing process of the π^0 meson. The deuteron vibration takes place in the muonic deuteron but not in the electronic deuteron because the muon is much closer to the deuteron than the electron. The distance of the electron from the deuteron is $r_{Bohr} = 5.29\ 10^{-11}$ m and the distance of the muon from the deuteron is $r_\mu = 2.557\ 10^{-13}$ m. Under this proposition, the average muonic deuteron radius ($r_{D\mu}$) can be calculated from the average muonic deuteron energy ($E_{D\mu}$). The deuteron energy ($E_D = mc^2 = 1875.6\ 10^6$ eV) is related to the deuteron radius by two equations of $E_D = 4.0864\ 10^{38}\ r_D^2$ (eV, m) and $E_D = 1.9074\ 10^{53}\ r_D^3$ (eV, m) where r_D is 2.1424(21) 10^{-15} m [6]. The obtained average deuteron energy ($E_{D\mu}$) is 1808.1 10^6 eV. Then the calculated average muonic deuteron radius ($r_{D\mu}$) is 2.10349 10^{-15} m from the equation of $E_D = 4.0864\ 10^{38}\ r_D^2$ (eV, m) and 2.11632 10^{-15} m from the equation of $E_D = 1.9074\ 10^{53}\ r_D^3$ (eV, m). The experimental muonic deuteron radius ($r_{D\mu}$) is 2.12562(78) 10^{-15} m [6]. The calculated average muonic deuteron radius of 2.11632 10^{-15} m is consistent with the experimental muonic deuteron radius of 2.12562(78) 10^{-15} m. Therefore, the deuteron charge radius problem can be explained by using the deuteron vibration connected with the π^0 meson.

[6] R. Pohl et al., Science **353**, 669 (2016).


e - e+ pair annihilation
e (−1,−2/3)
γ(0,0)
511 keV
511 keV
e+(1,2/3)
γ (0,0)
m_e c^2 = 511 keV
Z(0,0)
B1 - B̄1 pair annihilation
B1(−2/3)
x (0,0)
3.57 keV
3.57 keV
B̄1(2/3)
x (0,0)
m_B1 c^2 = 3.57 keV
Z(0)
Z(0,0)
Le - L̄e pair annihilation
Le (−1,−5/3)
γ(0,0)
375 GeV
375 GeV
L̄e (1,5/3)
γ (0,0)
m_Le c^2 = 375 GeV
Z(0,0)
B2 - B̄2 pair annihilation
B2(−5/3)
γ (0,0)
42.7 GeV
42.7 GeV
B̄2(5/3)
γ (0,0)
m_B2 c^2 = 42.7 GeV
Z(0)
Z(0,0)
Leptons
Bastons

π_d^0 144.2 MeV ---------- π^0 135 MeV

$d\bar{d}$ (-1/3,0,-2/3) (1/3,0,2/3) — $u\bar{u}$ (2/3,0,-2/3) (-2/3,0,2/3)

η_d 556.5 MeV ---------- η 547.3 MeV

$d\bar{d}$ (-1/3,0,-5/3) (1/3,0,5/3) — $u\bar{u}$ (2/3,0,-5/3) (-2/3,0,5/3)

f_{1d} 1294.2 MeV ---------- $f_1(1285)$

$d\bar{d}$ (-1/3,0,-8/3) (1/3,0,8/3) — $u\bar{u}$ (2/3,0,-8/3) (-2/3,0,8/3)

144.2 MeV π_d^0 $d\bar{d}$ $\longrightarrow$ 2γ (?) New

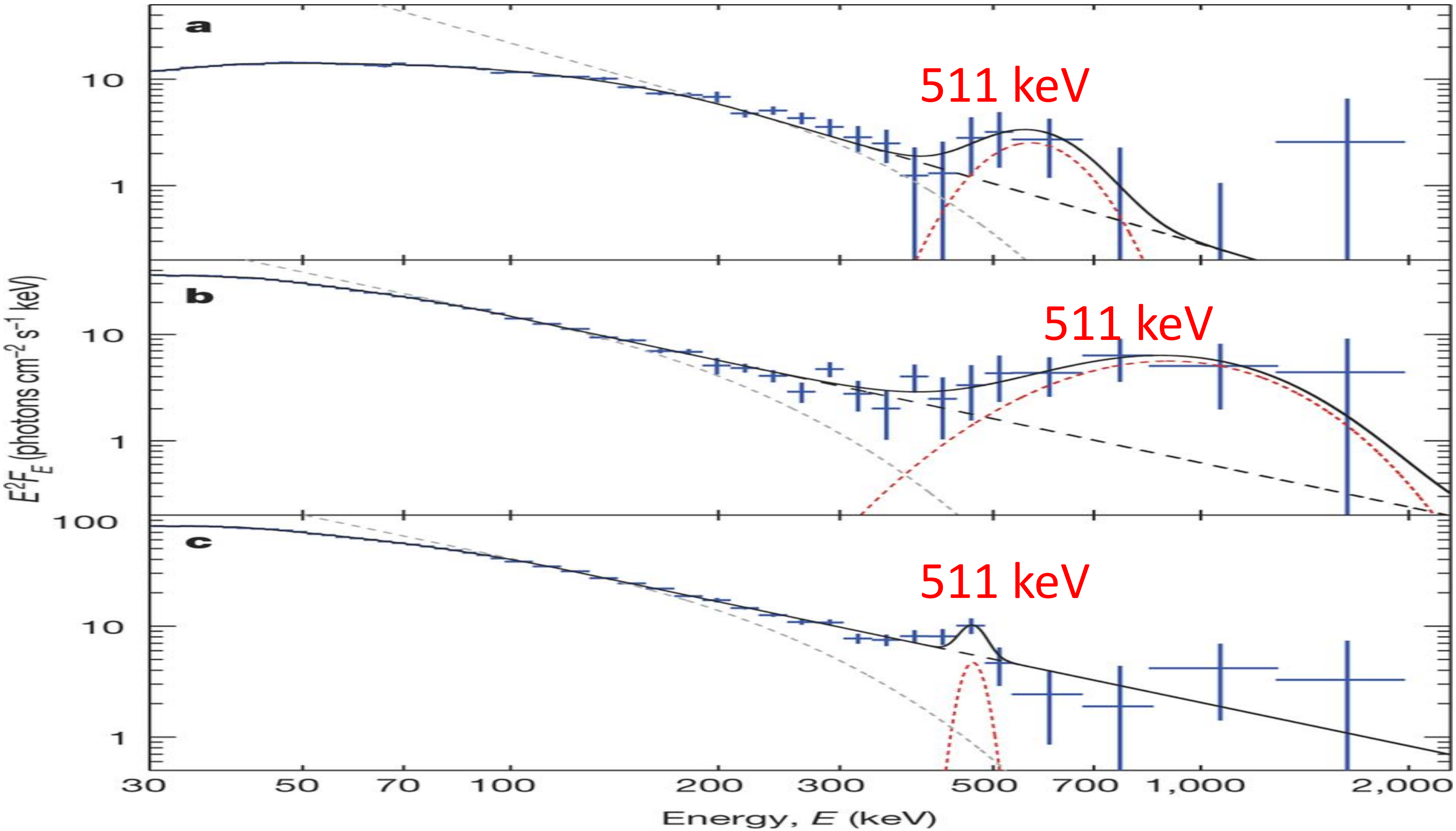
(-1/3,0,-2/3) (1/3,0,2/3) — (0,0) (0,0)

139.6 MeV π^+ $u\bar{d}$ $\longrightarrow$ $\mu^+ + \nu_\mu$

(2/3,0,-2/3) (1/3,0,2/3) — (1,5/3) (0,-5/3)

$\frac{u\bar{u} - d\bar{d}}{\sqrt{2}}$ 135 MeV π^0 $u\bar{u}$ $\longrightarrow$ 2γ

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



Spectral evolution of V404 Cygni. a-c, Spectra in the soft gamma-ray band in three different faring epochs (a-c show the spectra measured in INTEGRAL orbits 1554, 1555 and 1557, corresponding to epochs 1, 2 and 3, respectively).

T. Siegert et al., arXiv:1603.01169 (2016).

Electron-positron annihilation peak at 511 keV.

Summary

Elementary particle decays and reactions are discussed in terms of the three-dimensional quantized space model beyond the standard model. Three generations of the leptons and quarks correspond to the lepton charges. Three heavy leptons and three heavy quarks are introduced. And the bastons (new particles) are proposed as the possible candidate of the dark matters. Dark matter force, weak force and strong force are explained consistently. Also, it is shown that, because of the non-zero lepton charge, the neutrino is not the Majorana particle. Possible rest masses of the new particles are, tentatively, proposed for the experimental searches. The unknown neutral X boson with the rest mass of 16.7 MeV/c^2 is proposed as the Koron of π_1^0 with e and e^+ which can explain the cosmic Lithium problem.

- See, for more details, the papers of
- “Dark matters, proton radius problem, cosmic lithium problem, elementary particles and new extended standard model”,
- “Elementary Particles, dark matter candidate and new extended standard model”, and
- “Three-dimensional quantized spaces, universe, elementary particles, quantum mechanics, general relativity theory and dark matters”
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