Romanian Educators to CMS

Standard Model

part 2

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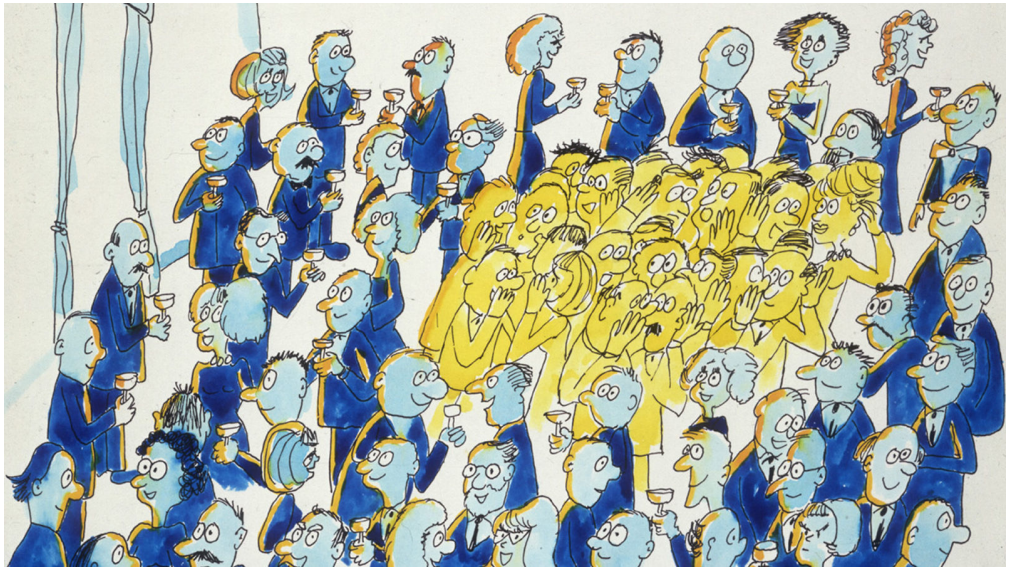
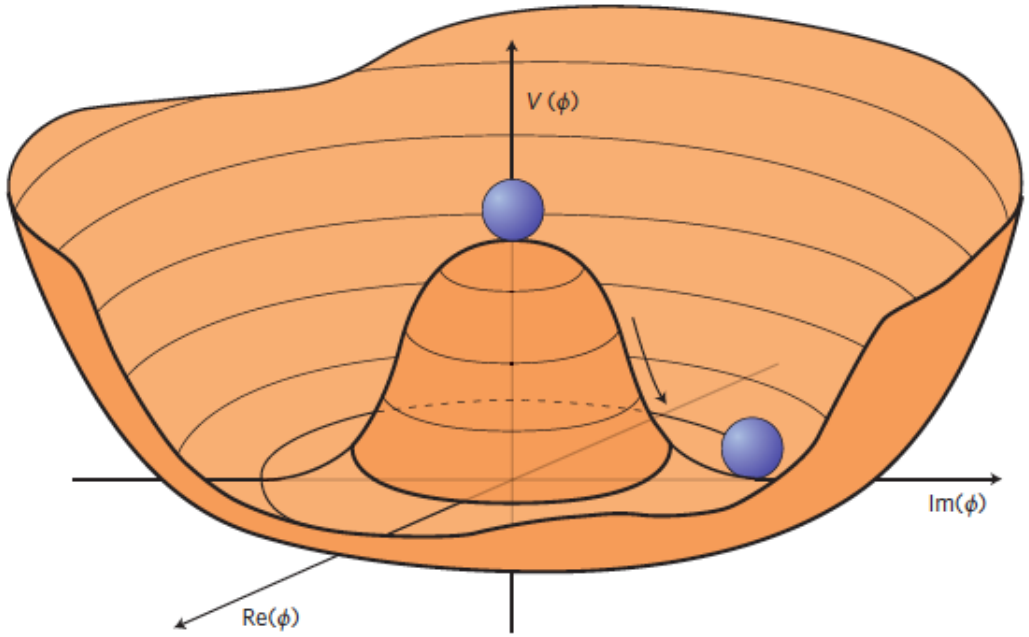
18 Apr 2023

Conținut

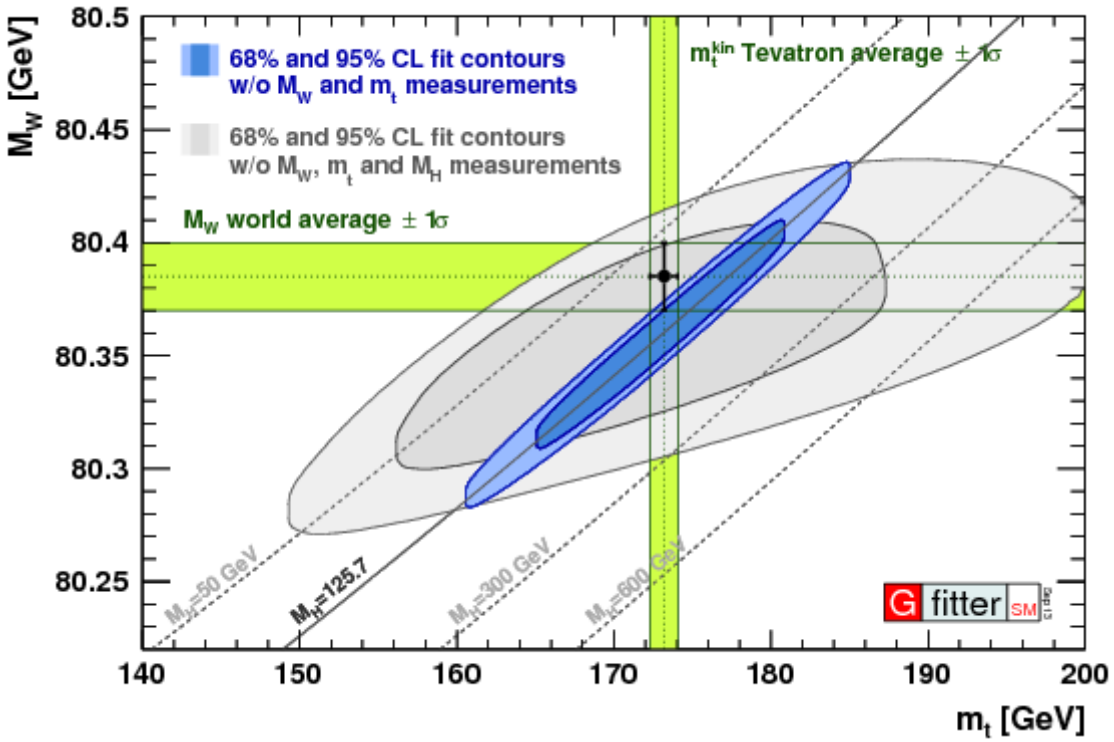
- Higgs
- Simetrii și încălcarea sarcină-paritate
- Fizica aromei grele
- Oscilațiile cuarcilor
- Neutrini
- Dincolo de Modelul Standard
- Resurse

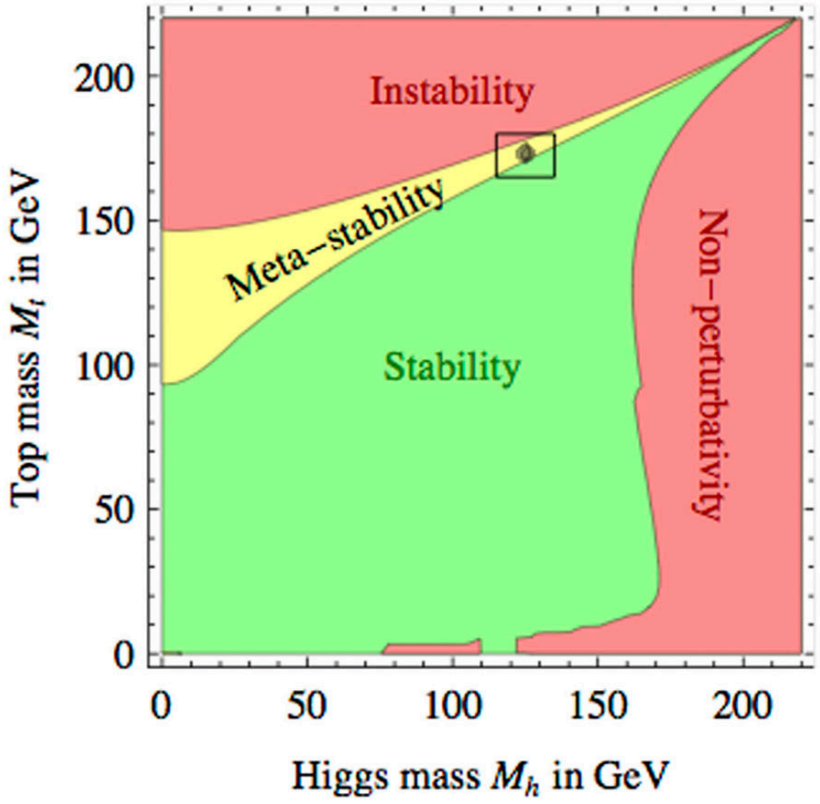
Ce studiem la CERN: bosonul Higgs





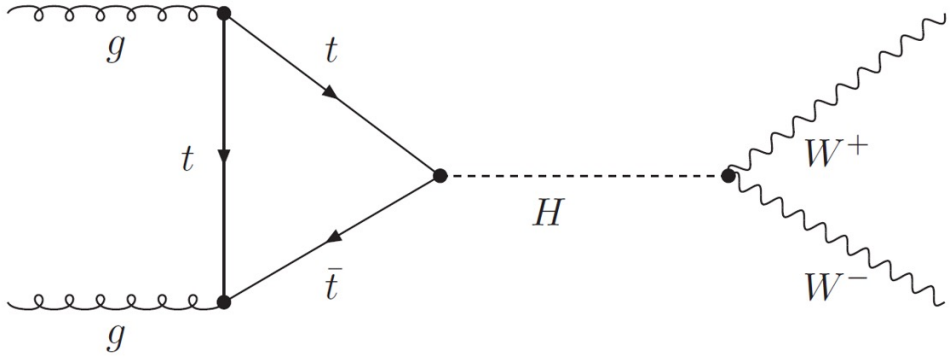
Ce studiem la CERN: bosonul Higgs

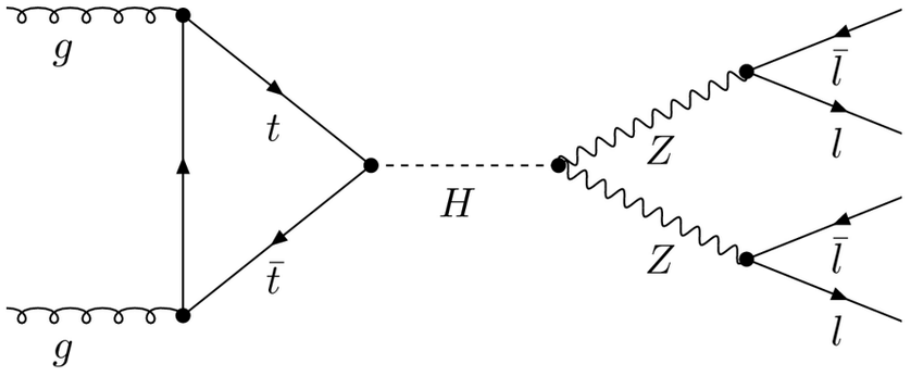




Ce studiem la CERN: bosonul Higgs

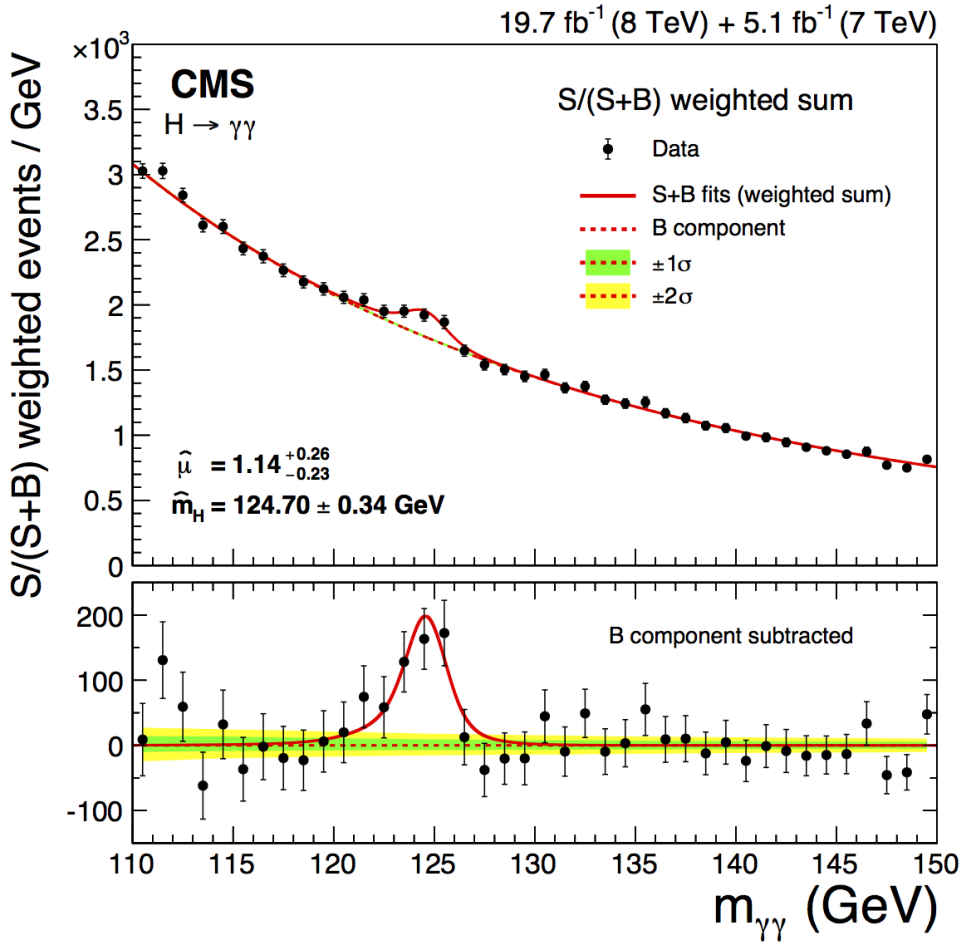
Din punctul de vedere al experimentalistului, ce diagramă preferați?

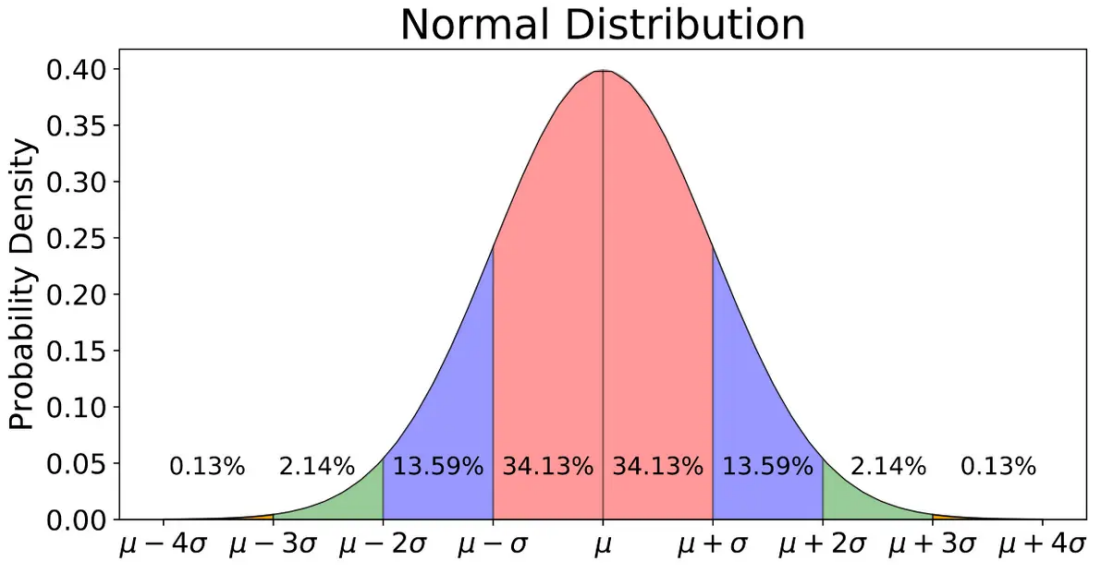




Cum suntem siguri de o descoperire?

Cum suntem siguri de o descoperire?

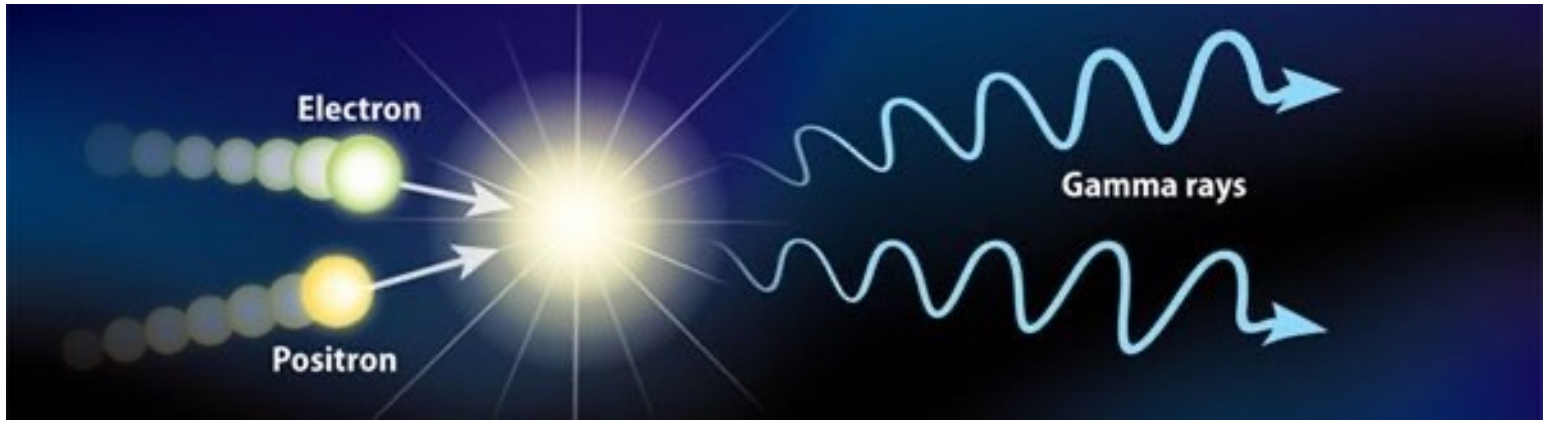


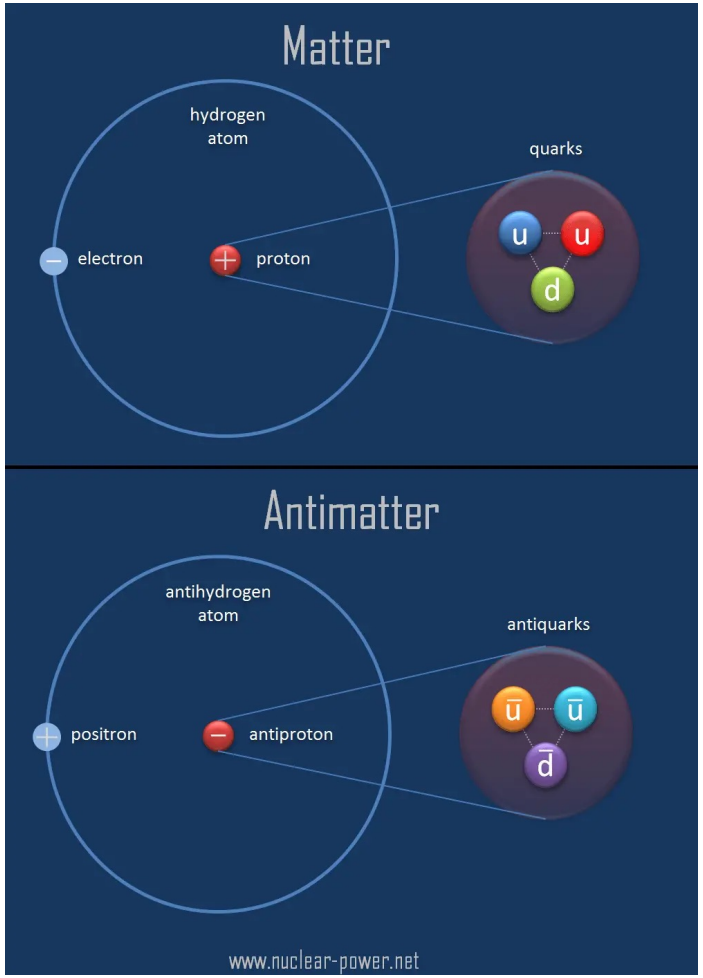


5σ -> probabilitate de 1 la un milion de a fi coincidență!!

Antimateria

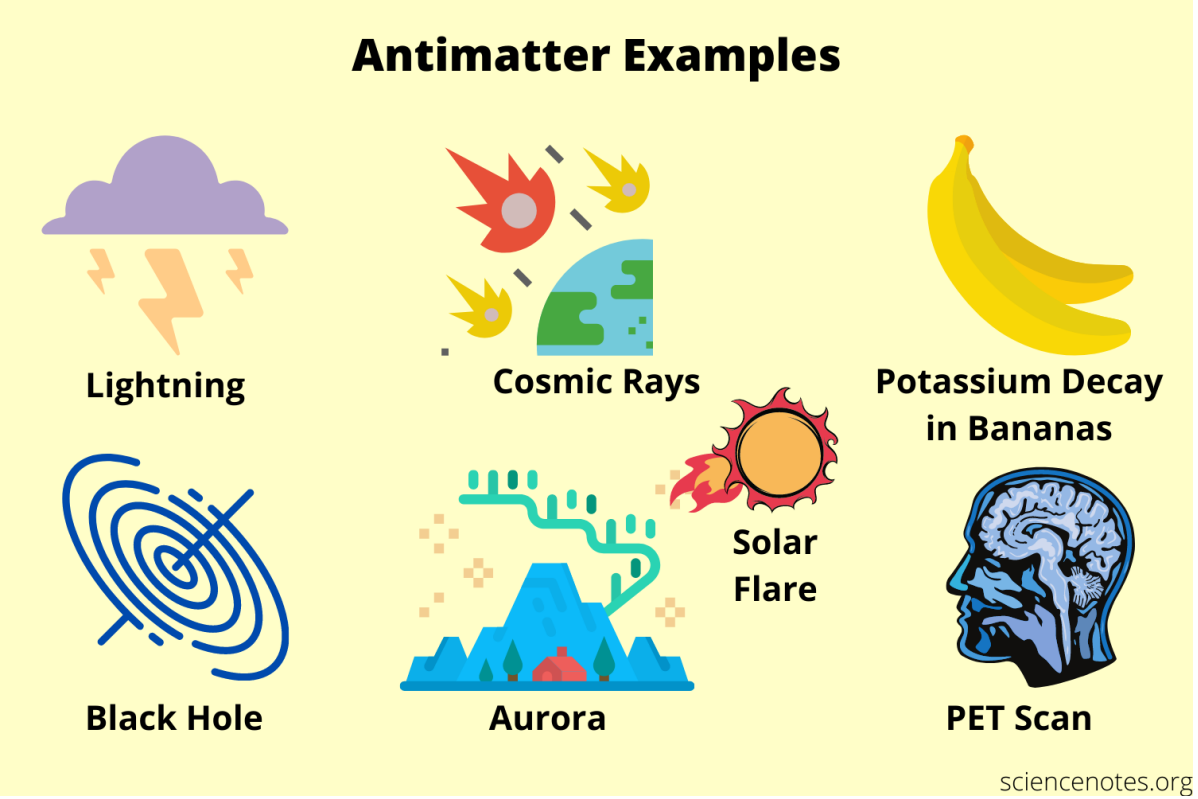
- Fiecare fermion are un anti-fermion de aceeași masa și sarcină electrică (și spin) opus -> soluția negativă a unei ecuații cuadratice
- Când materia și antimateria se întâlnesc se anihilează emițând energie
- La începutul universului materia și antimateria au fost produse în mod egal



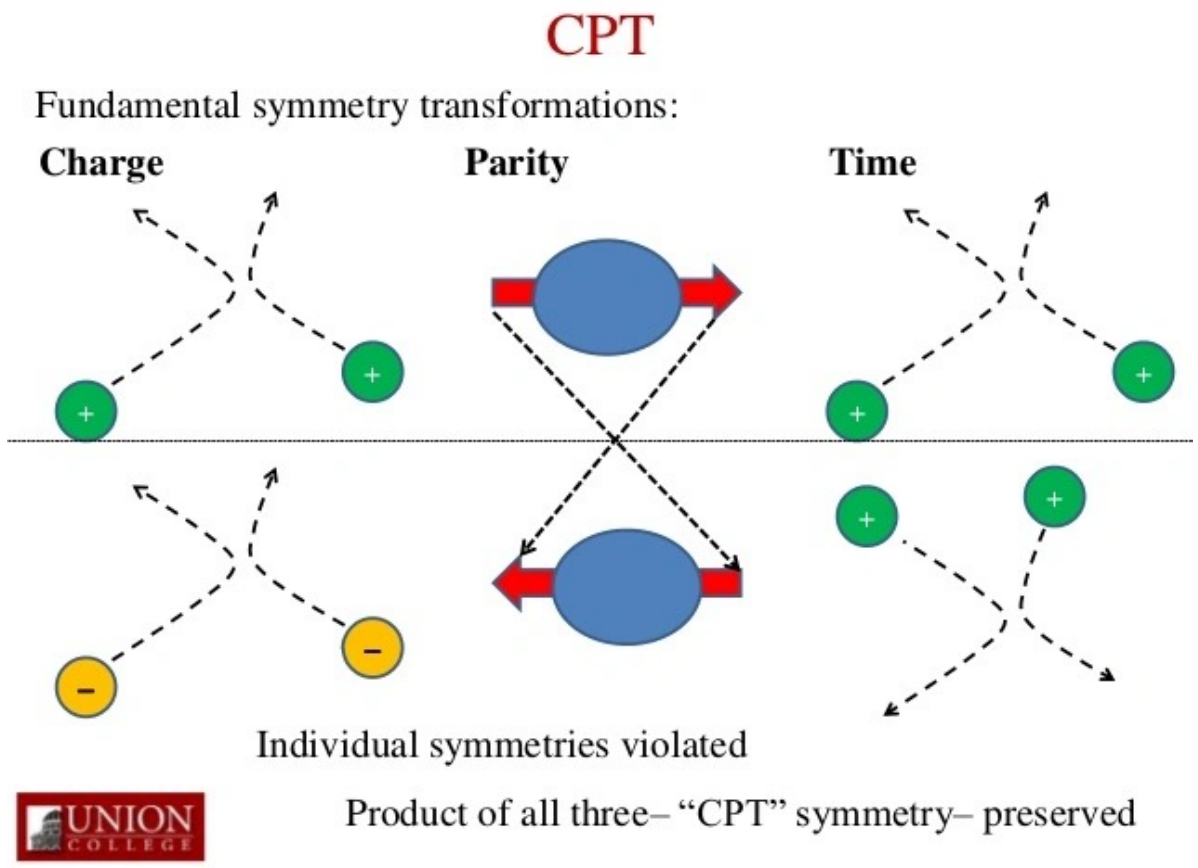


Antimateria

- Costă $62 trillioane/gram

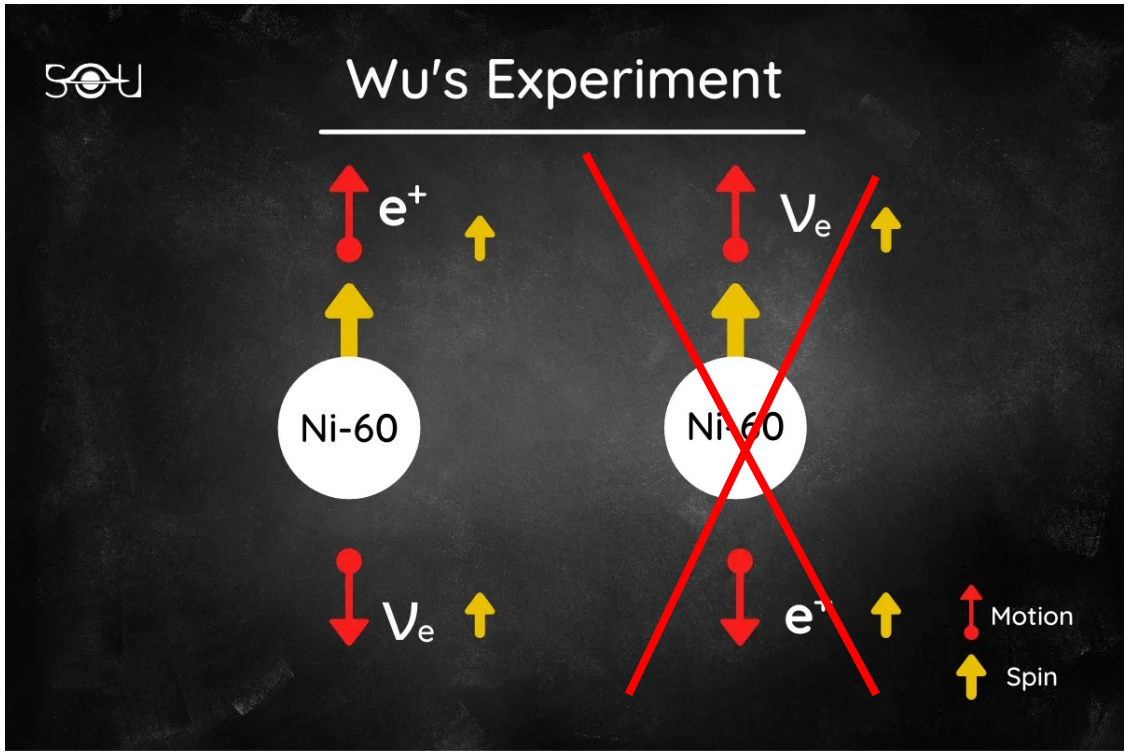


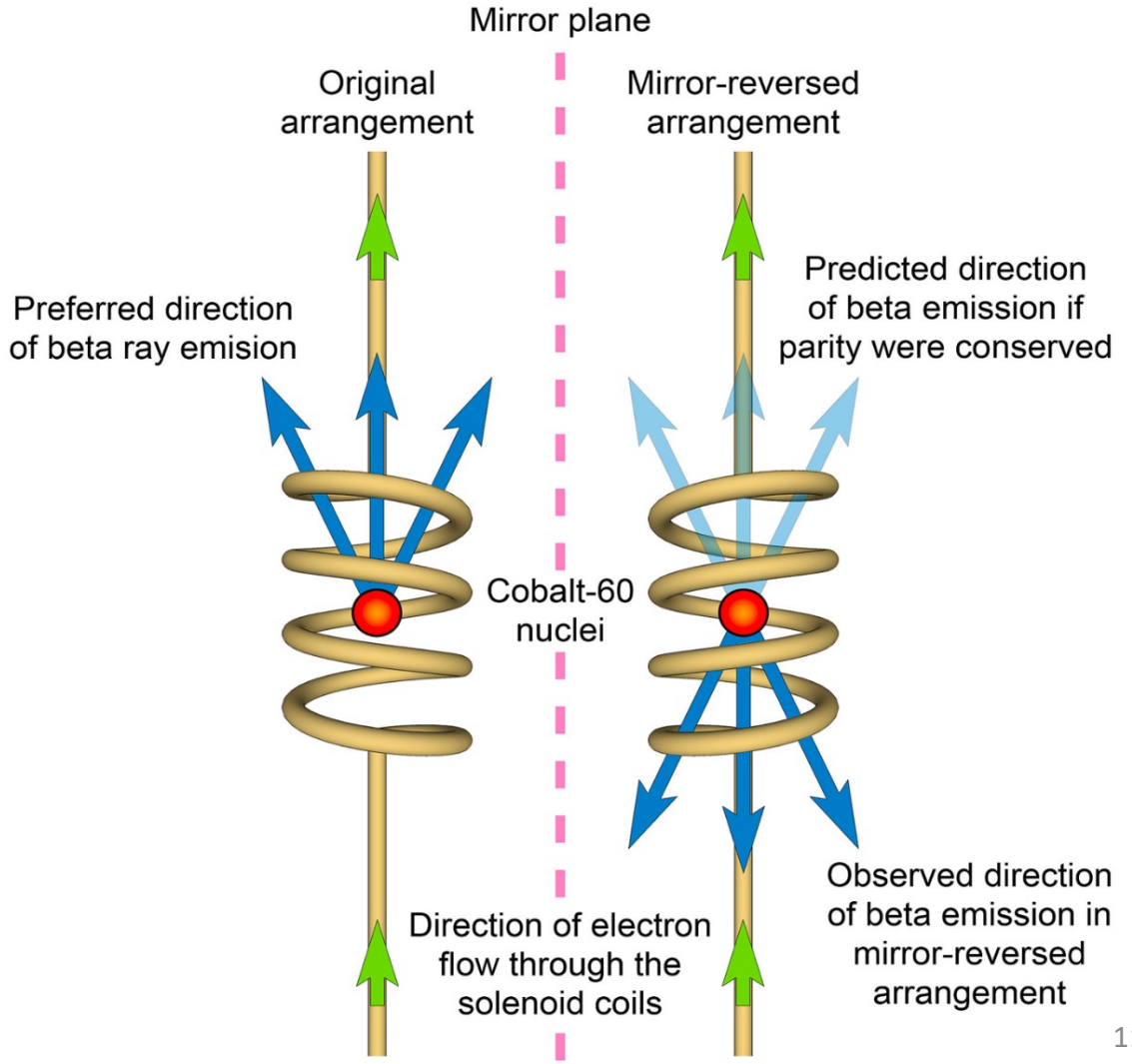
Simetrii



Un proces fizic este neschimbat după aplicarea unei transformări sarcină-paritate-timp

Încălcarea sarcină-paritate

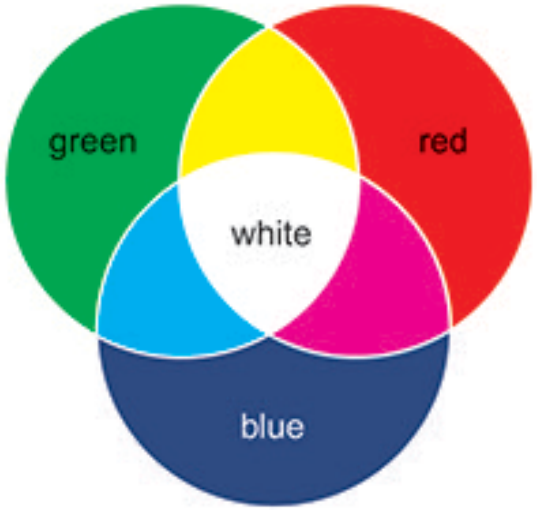




Cromodinamică cuantică

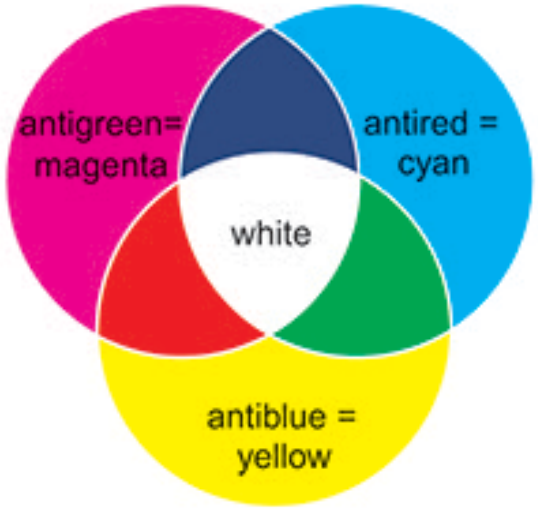
Într-o grupare de cuarci, fiecăruia îi este asociată o culoare astfel încât combinația tutuor cuarcilor să fie albă -> de exemplu mesonul η_c are compoziție $c\bar{c}$

cuarci



(a)

anti-cuarci

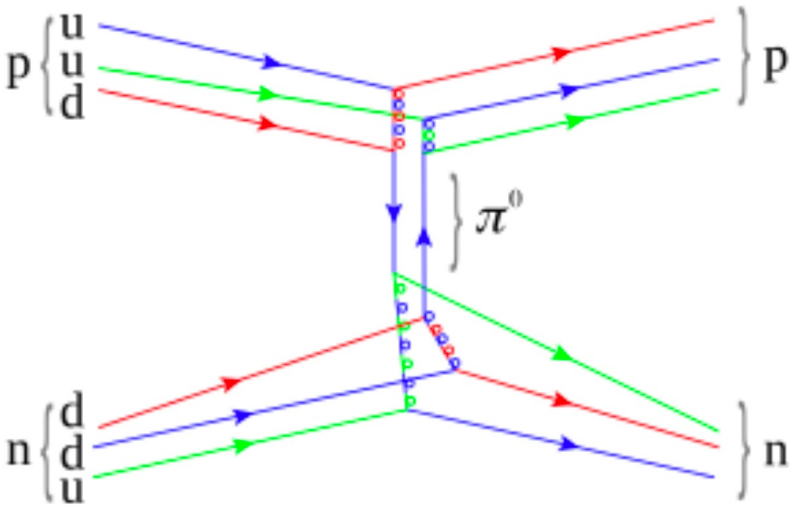


(b)

Quiz: ce grupare nu e posibilă?

A. uud
B. $u\bar{u}d$
C. udc

Mesoni



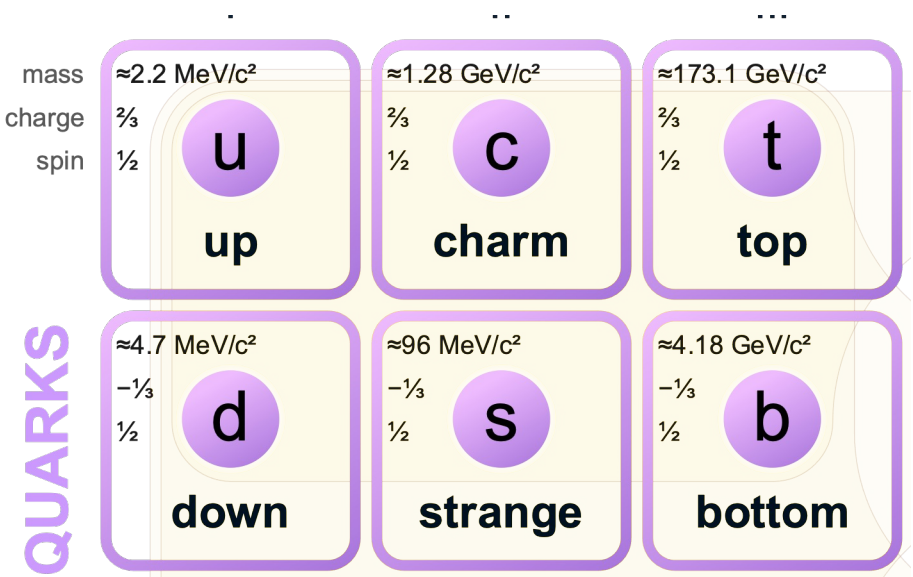
Mesons $q\bar{q}$ Mesons are bosonic hadrons These are a few of the many types of mesons.					
Symbol	Name	Quark content	Electric charge	Mass GeV/c^2	Spin
π^+	pion	$\mathbf{u\bar{d}}$	+1	0.140	0
$\mathbf{K^-}$	kaon	$\mathbf{s\bar{u}}$	–1	0.494	0
ρ^+	rho	$\mathbf{u\bar{d}}$	+1	0.776	1
B^0	B-zero	$\mathbf{d\bar{b}}$	0	5.279	0
η_c	eta-c	$\mathbf{c\bar{c}}$	0	2.980	0

Oscilațiile cuarcilor

- Cuarcii pe care îi obsevăm sunt de fapt superpoziții ale aromelor posibile de cuarci u, d, s …

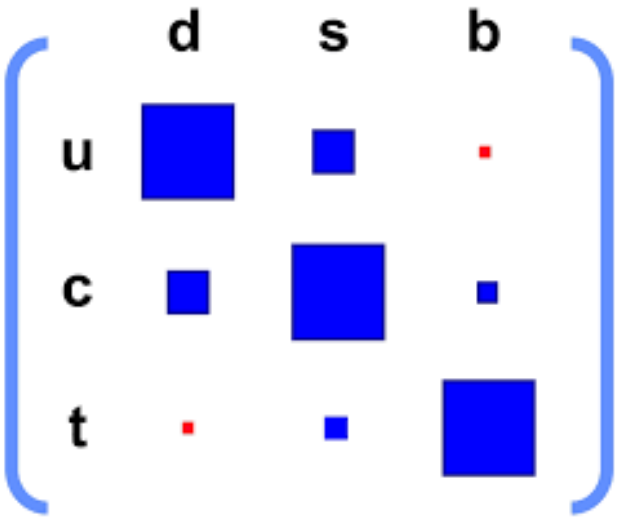
probabilitatea tranziției d -> u

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix} = V_{CKM} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

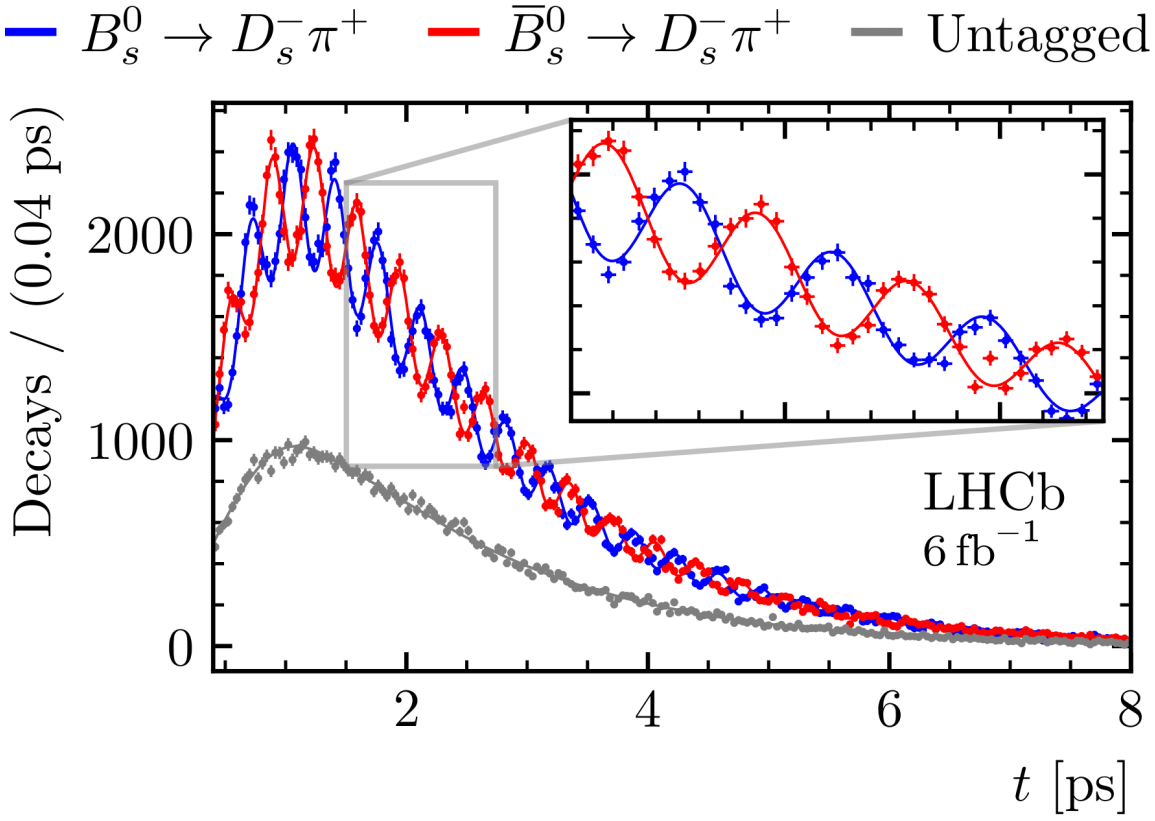


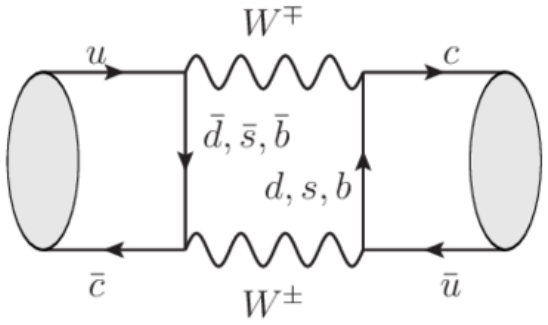
Oscilațiile cuarcilor

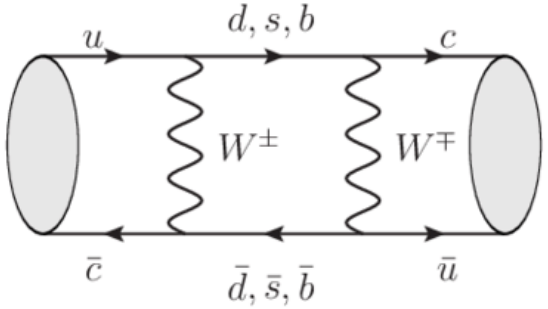
$$\begin{bmatrix} |V_{ud}| & |V_{us}| & |V_{ub}| \\ |V_{cd}| & |V_{cs}| & |V_{cb}| \\ |V_{td}| & |V_{ts}| & |V_{tb}| \end{bmatrix} \approx \begin{bmatrix} 0.974 & 0.225 & 0.003 \\ 0.225 & 0.973 & 0.041 \\ 0.009 & 0.040 & 0.999 \end{bmatrix}$$



Oscilațiile mesonilor

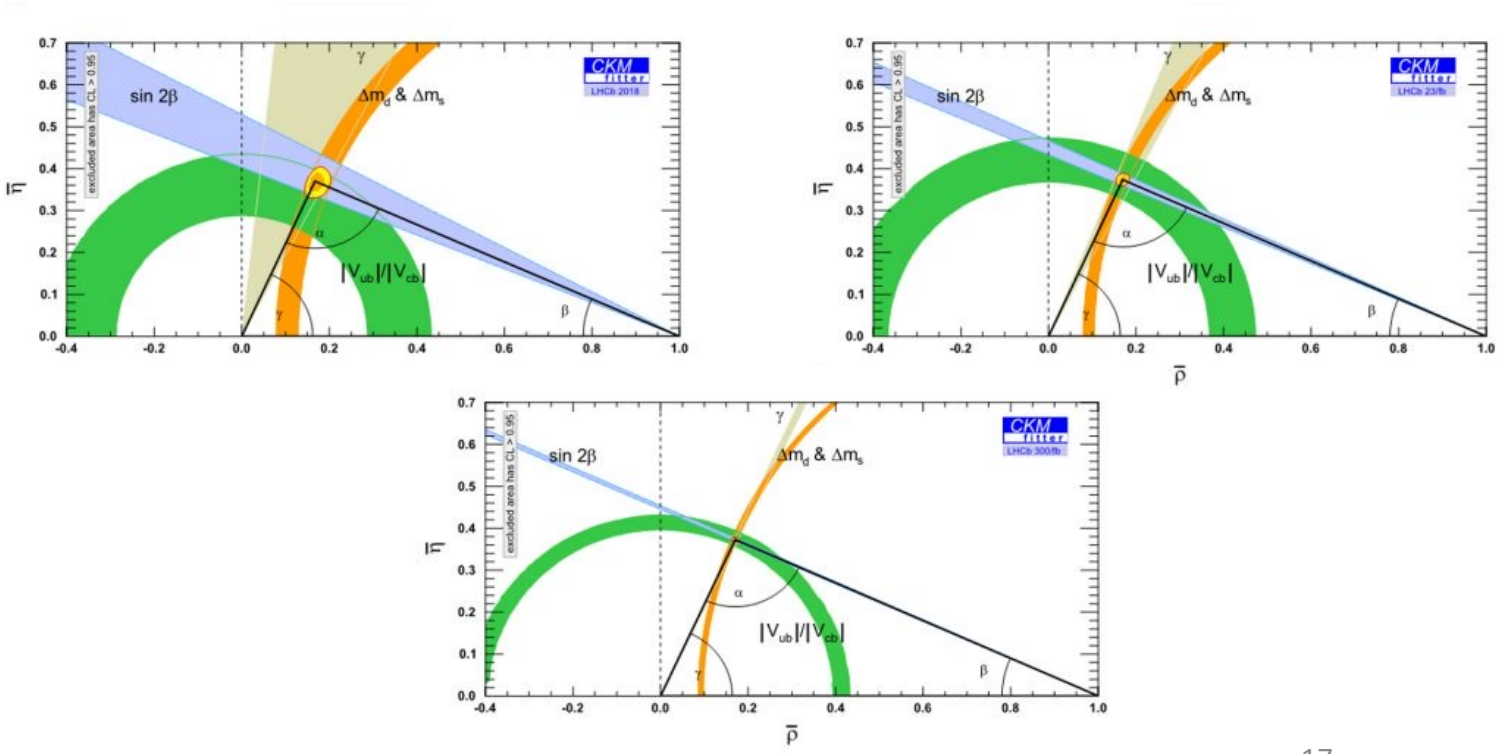






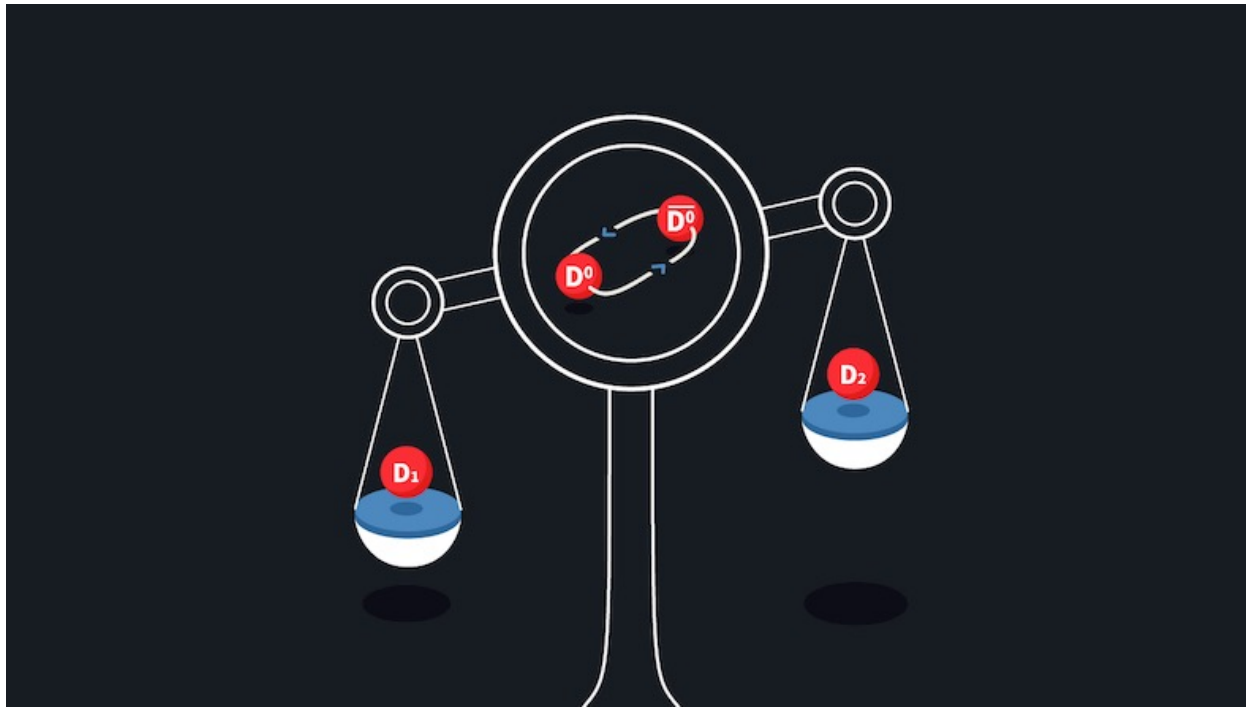
Încălcarea sarcină-paritate

Descoperire 2019: mesonii D^0 de tip materie se dezintegrează la o rată diferită de anti-materie



Încălcarea sarcină-paritate

Încă se caută încălcarea sarcină-paritate în oscilații



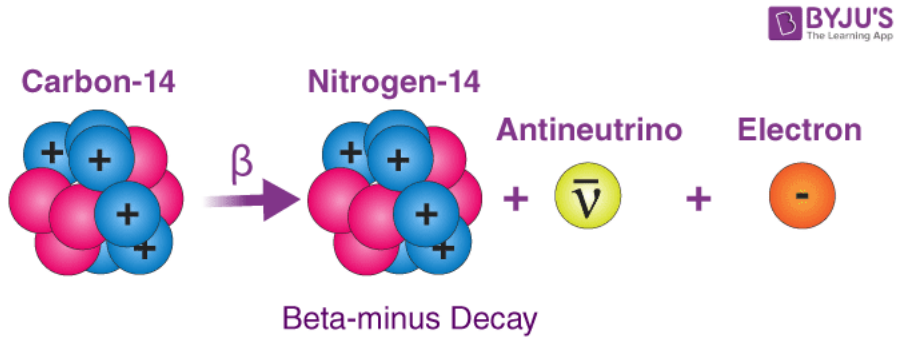
Neutrini

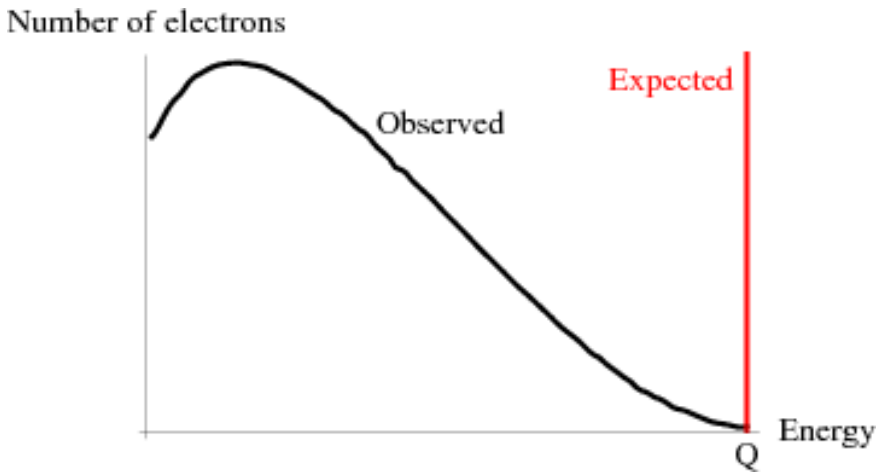
Physikalisches Institut
der Eidg. Technischen Hochschule
Zürich

Zürich, 4. Dez. 1930
Gloriastrasse

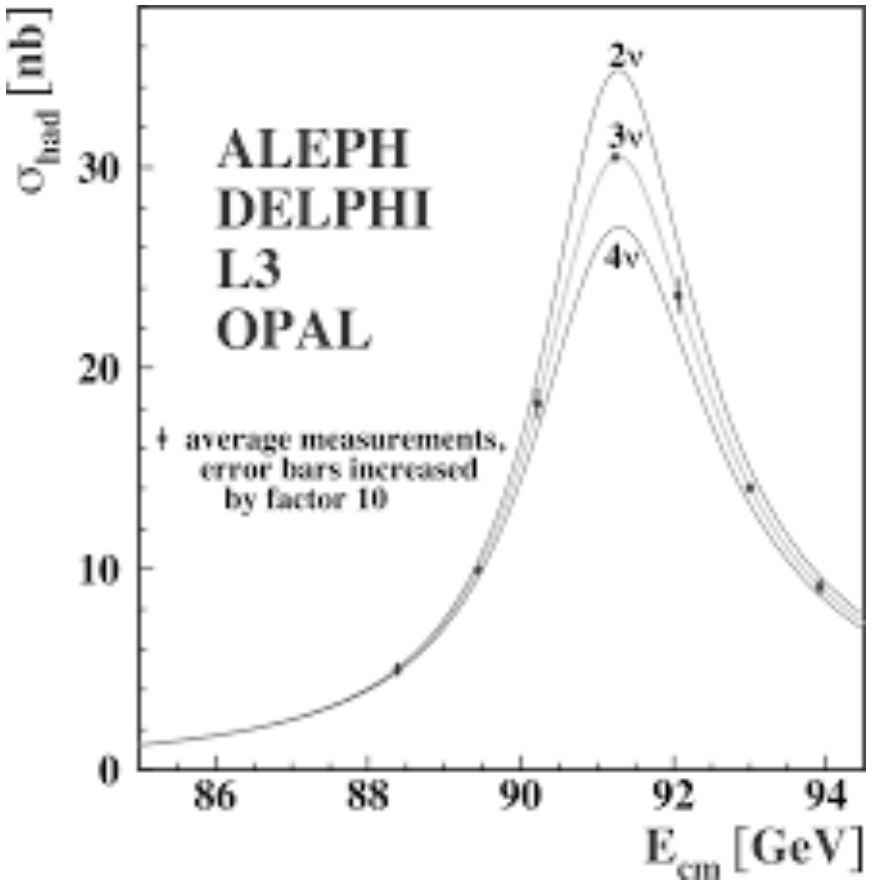
Liebe Radioaktive Damen und Herren,

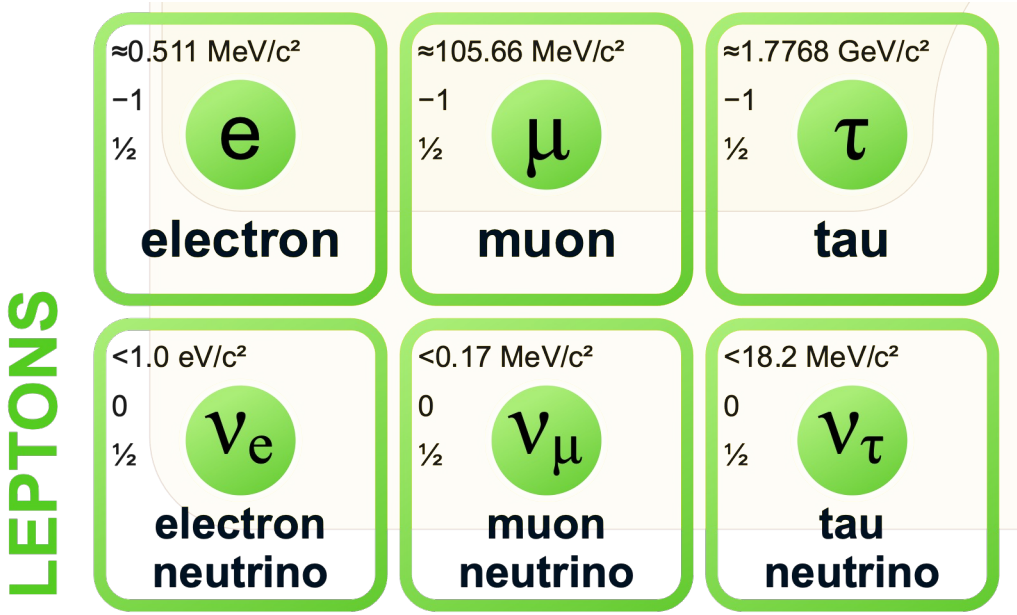
Wie der Ueberbringer dieser Zeilen, den ich huldvollst ansuhören bitte, Ihnen des näheren auseinandersetzen wird, bin ich angesichts der "falschen" Statistik der N- und Li-6 Kerne, sowie des kontinuierlichen beta-Spektrums auf einen verzweifelten Ausweg verfallen um den "Wechselsatz" (1) der Statistik und den Energiesatz zu retten. Nämlich die Möglichkeit, es könnten elektrisch neutrale Teilchen, die ich Neutronen nennen will, in den Kernen existieren, welche den Spin 1/2 haben und das Ausschliessungsprinzip befolgen und sich von Lichtquanten ausserdem noch dadurch unterscheiden, dass sie nicht mit Lichtgeschwindigkeit laufen. Die Masse der Neutronen müsste von derselben Grössenordnung wie die Elektronenmasse sein und jedenfalls nicht grösser als 0,01 Protonenmasse.- Das kontinuierliche beta- Spektrum wäre dann verständlich unter der Annahme, dass beim beta-Zerfall mit dem Elektron jeweils noch ein Neutron emittiert wird, derart, dass die Summe der Energien von Neutron und Elektron konstant ist.





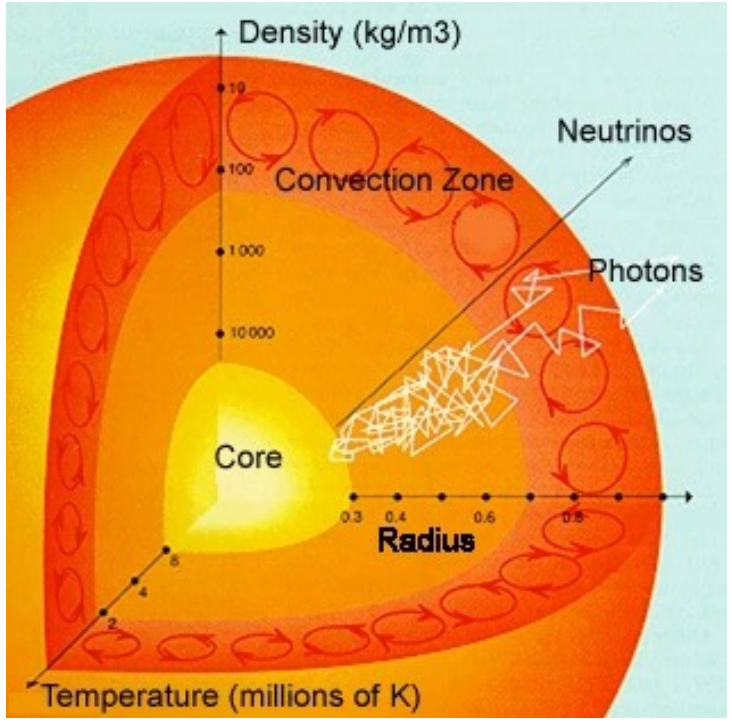
Neutrini

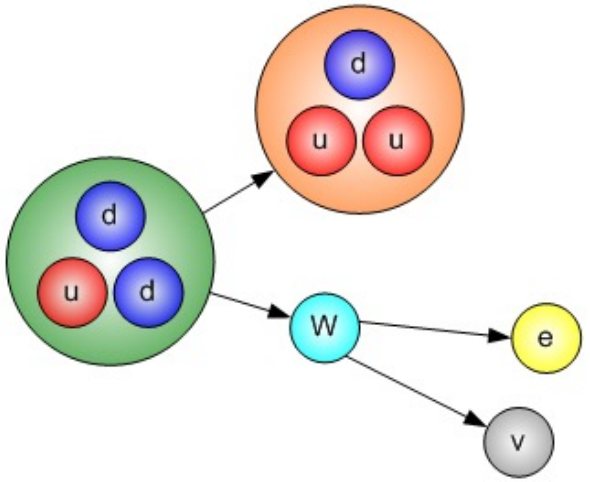

σ_{had} [nb]
30
20
10
0
ALEPH
DELPHI
L3
OPAL
average measurements, error bars increased by factor 10
2ν
3ν
4ν
86
88
90
92
94
E_{cm} [GeV]

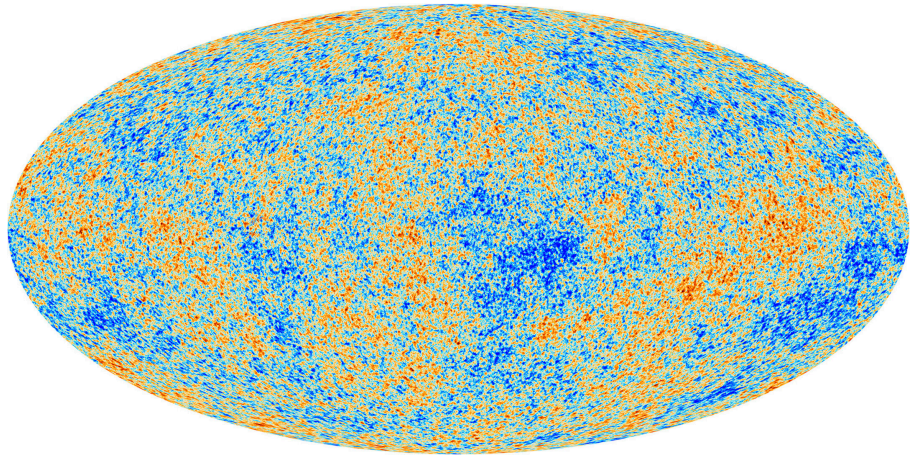

LEPTONS
≈0.511 MeV/c²
−1
½
e
electron
≈105.66 MeV/c²
−1
½
μ
muon
≈1.7768 GeV/c²
−1
½
τ
tau
<1.0 eV/c²
0
½
ν_e
electron neutrino
<0.17 MeV/c²
0
½
ν_μ
muon neutrino
<18.2 MeV/c²
0
½
ν_τ
tau neutrino

Neutrini

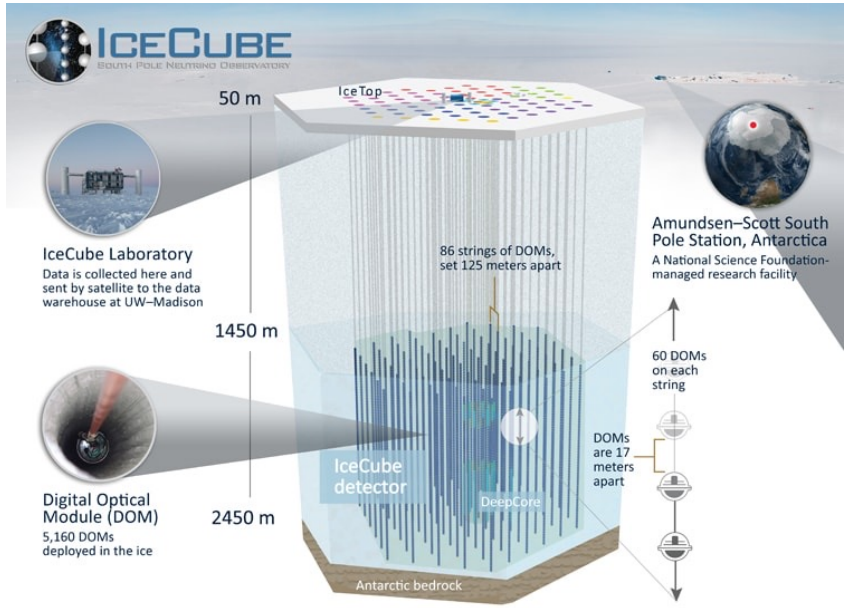
Aproximativ 100 trilioane de neutrini trec prin corpul nostru în fiecare secundă!
Dar ei interacționează extrem de slab cu materia.

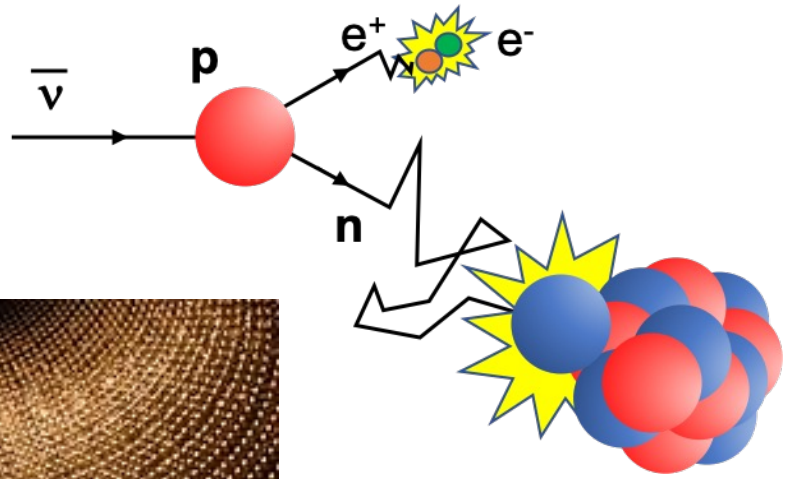


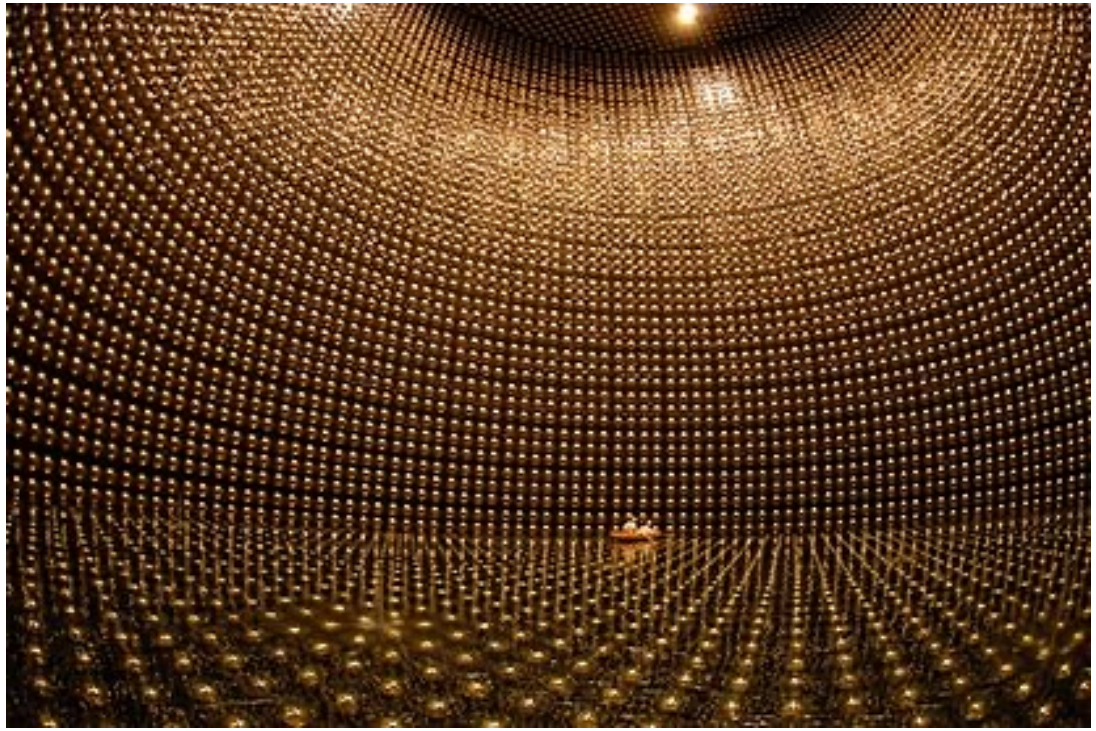




Neutrini detectare



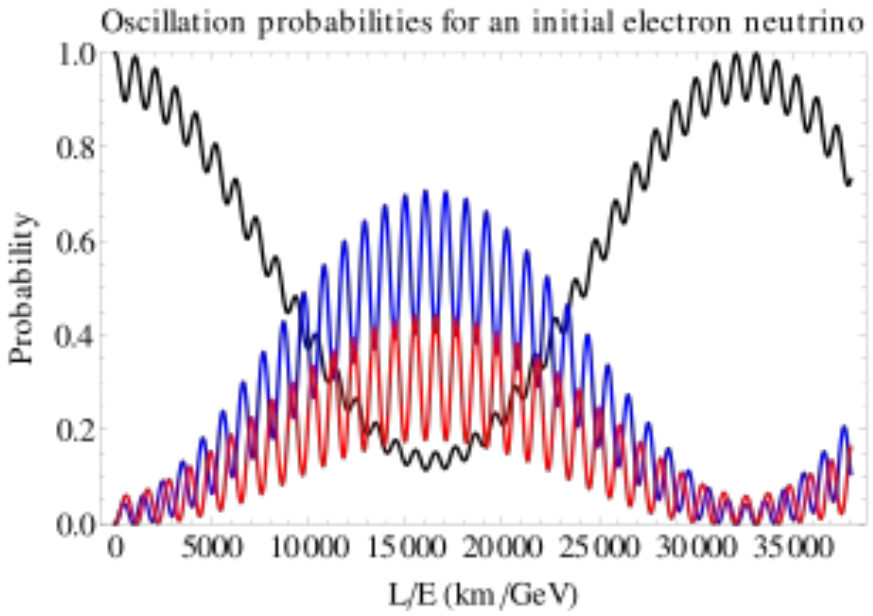


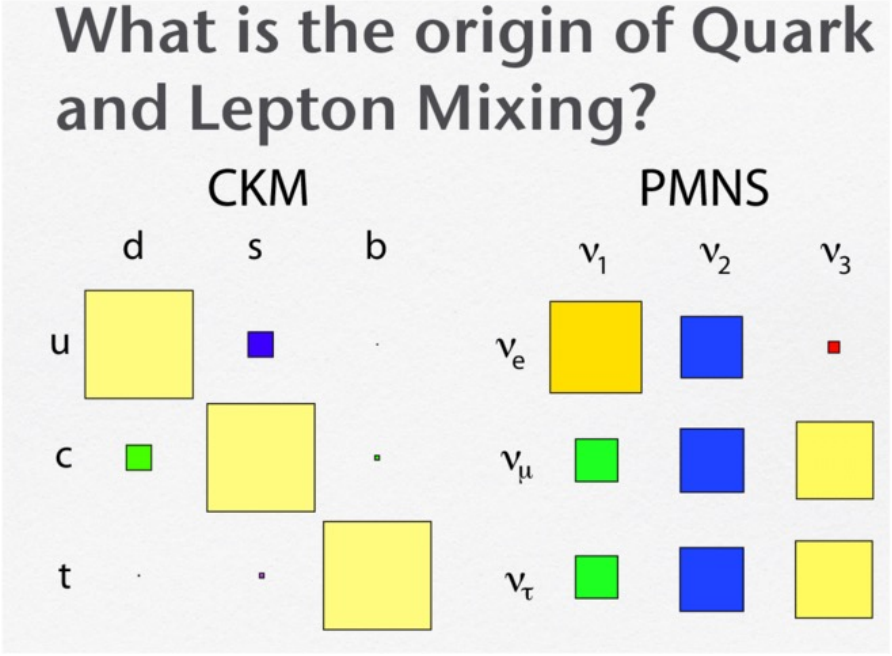


Neutrini

Modelul Standard prezice că neutrinii nu au masa, dar ei oscilează!

Știm că trebuie să existe o teorie mai bună decât Modelul Standard!





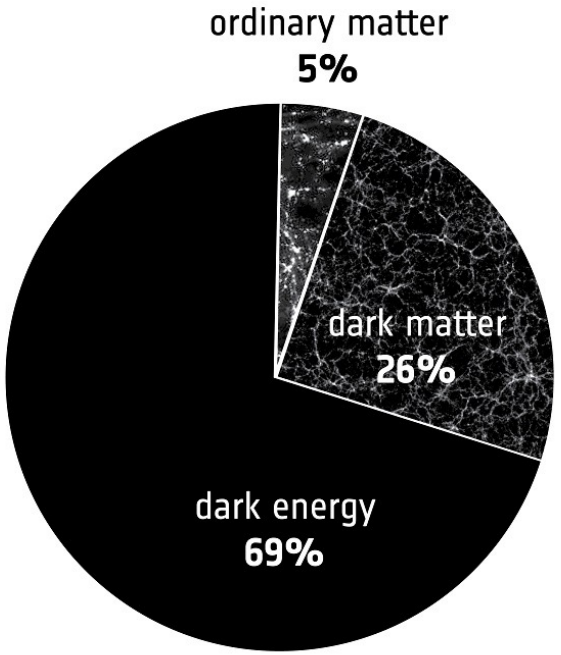
Dincolo de Modelul Standard

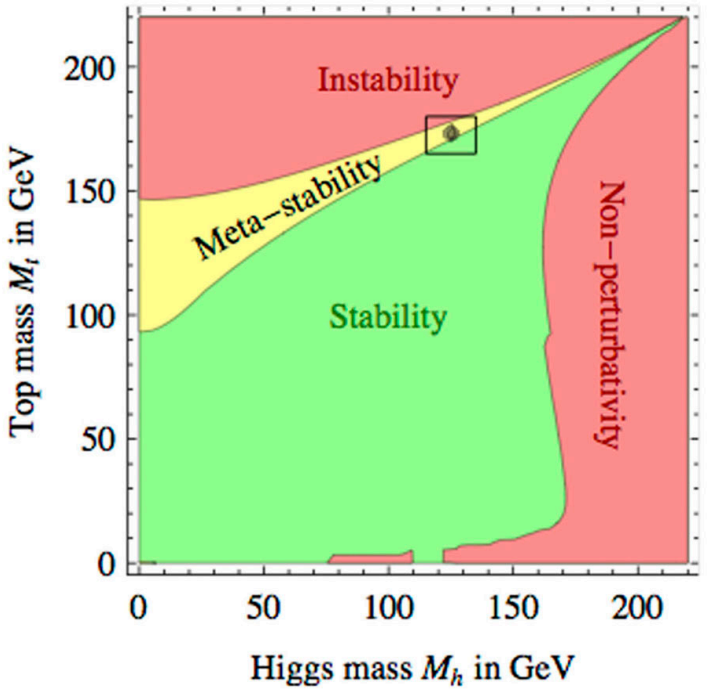
Peste 40 de premii Nobel pentru fizica particulelor

Dincolo de Modelul Standard

Modelul Standard NU explică:

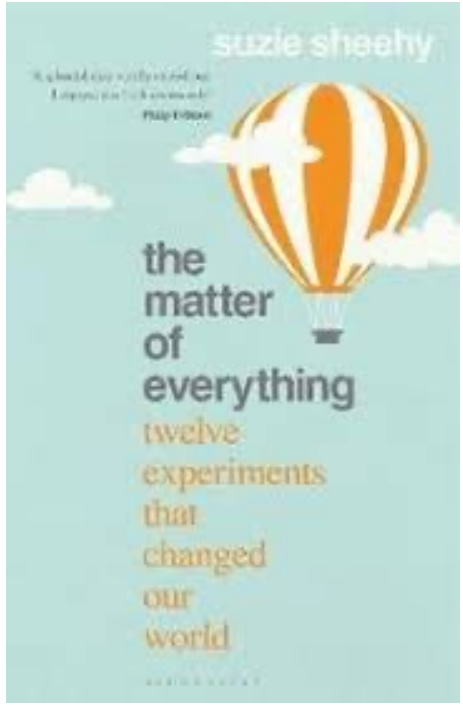
- Gravitația
- Materia întunecată
- Energia întunecată
- Oscilațiile neutrinilor

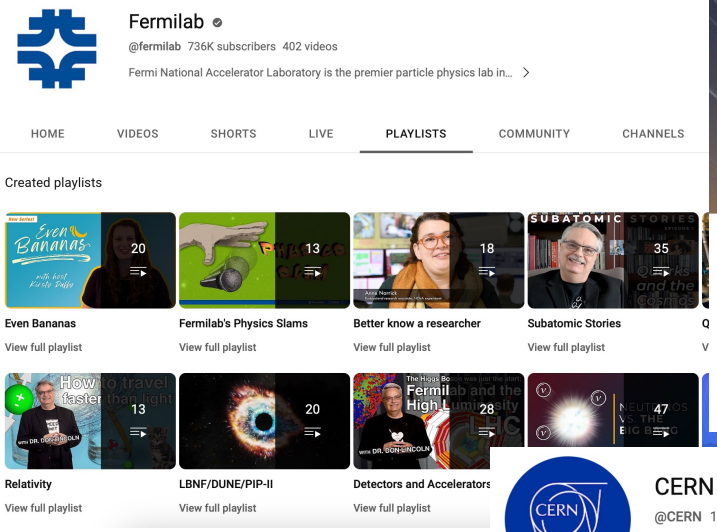


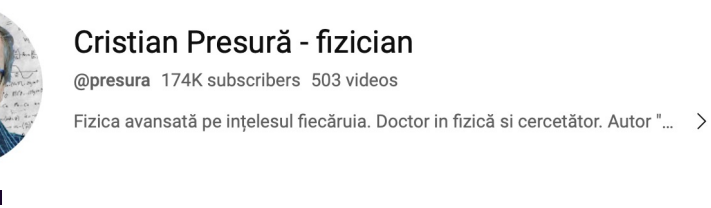


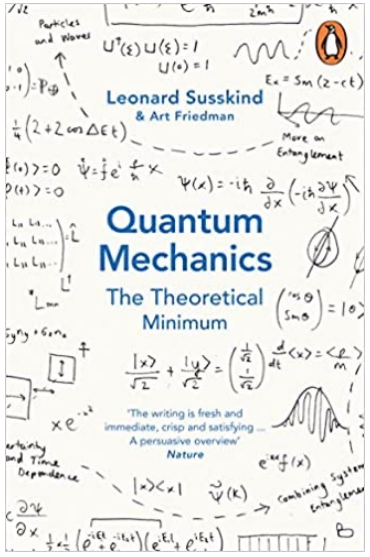
De asemenea, de ce este masa bosonului Higgs atât de mică?
Există mai multe procese care încalcă simetria sarcină-paritate?

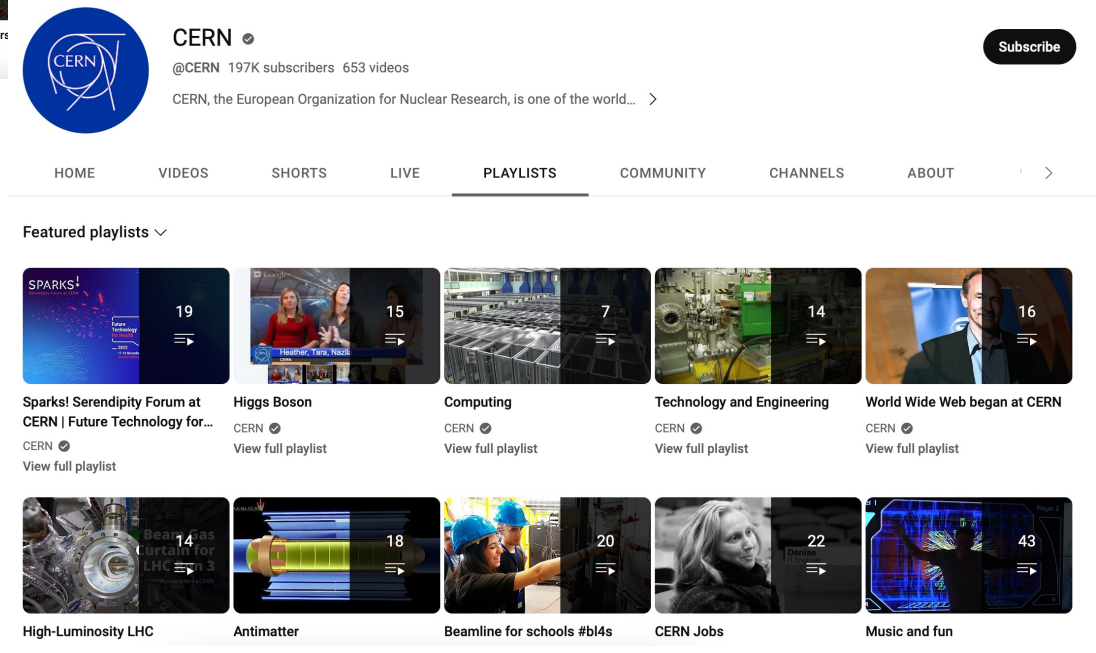
Recomandări











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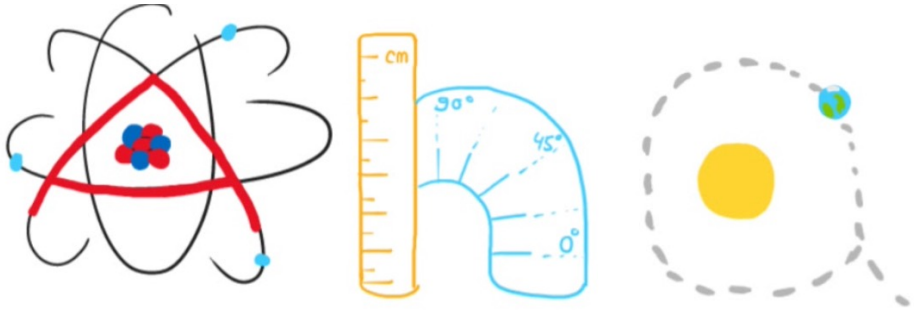
https://www.facebook.com/profile.php?id=100008223342402



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Bună! Eu sunt Cristina, am studiat fizică teoretică în Manchester și în curâ...

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