

Standard model

Quasi tutto quello che sappiamo sul mondo

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Outline

- 1 Particelle elementari
- 2 Interazioni
- 3 Simmetria e leggi di conservazione
- 4 Higgs Boson
- 5 Premi Nobel
- 6 Cosa manca?

Alcune Particelle

LEPTONS

0.511 MeV/c²
-1
1/2
e
electron

<2.2 eV/c²
0
1/2
 ν_e
electron
neutrino

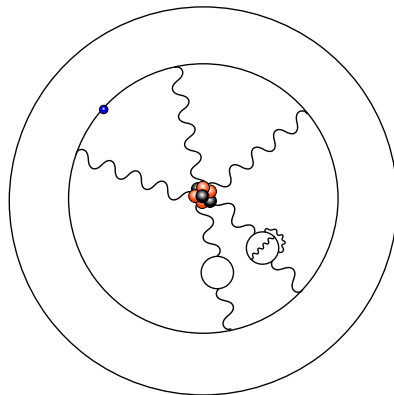
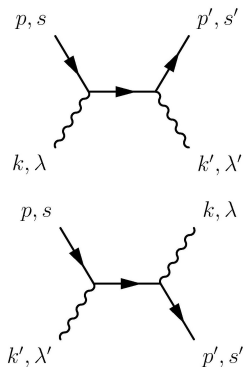
938.3 MeV/c²
1
1/2
p
proton

939.6 MeV/c²
0
1/2
n
neutron

GAUGE BOSONS

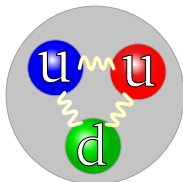
0
1
 γ
photon

Elettromagnetismo

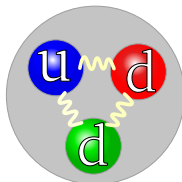


Decadimenti

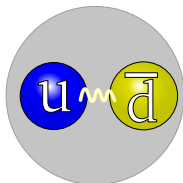
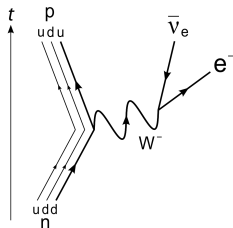
Protone



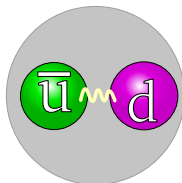
Neutrone



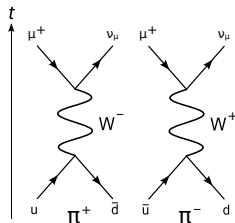
Decadimento β



π^+



π^-



Caratteristiche delle particelle

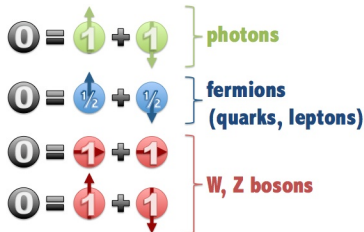
Massa $E^2 = m_0^2 c^4 + p^2 c^2$

Carica Interazioni con i fotoni

Colore Interazioni con i gluoni

Spin Trottole:
ma cos'è che ruota?

Sapore Generazioni di fermioni



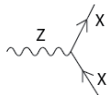
Decadimenti

Particelle pesanti decadono in particelle più leggere
ma devono conservare i numeri quantici.

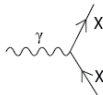
Particelle elementari

QUARKS	mass → $\approx 2.3 \text{ MeV}/c^2$ charge → $2/3$ spin → $1/2$  up	mass → $\approx 1.275 \text{ GeV}/c^2$ charge → $2/3$ spin → $1/2$  charm	mass → $\approx 173.07 \text{ GeV}/c^2$ charge → $2/3$ spin → $1/2$  top	GAUGE BOSONS	0 0 1  gluon
	mass → $\approx 4.8 \text{ MeV}/c^2$ charge → $-1/3$ spin → $1/2$  down	mass → $\approx 95 \text{ MeV}/c^2$ charge → $-1/3$ spin → $1/2$  strange	mass → $\approx 4.18 \text{ GeV}/c^2$ charge → $-1/3$ spin → $1/2$  bottom		
LEPTONS	0.511 MeV/c^2 -1 $1/2$  electron	105.7 MeV/c^2 -1 $1/2$  muon	1.777 GeV/c^2 -1 $1/2$  tau		0 0 1  photon
					$\approx 126 \text{ GeV}/c^2$ 0 0 0  Higgs boson
	$< 2.2 \text{ eV}/c^2$ 0 $1/2$  electron neutrino	$< 0.17 \text{ MeV}/c^2$ 0 $1/2$  muon neutrino	$< 15.5 \text{ MeV}/c^2$ 0 $1/2$  tau neutrino		80.4 GeV/c^2 ± 1 1  W boson
					91.2 GeV/c^2 0 1  Z boson

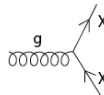
Standard Model Interactions (Forces Mediated by Gauge Bosons)



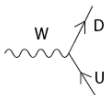
X is any fermion in the Standard Model.



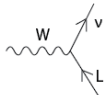
X is electrically charged.



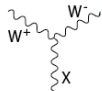
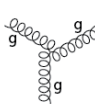
X is any quark.



U is a up-type quark;
D is a down-type quark.



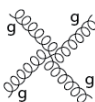
L is a lepton and ν is the corresponding neutrino.



X is a photon or Z-boson.



X and Y are any two electroweak bosons such that charge is conserved.



Simmetria e leggi di conservazione

Emily Noether 1918:

“Ad ogni simmetria corrisponde una quantità conservata”.

Traslazioni spaziali Il momento (quantità di moto) si conserva

Traslazioni temporali L'energia si conserva

Rotazioni Il momento angolare si conserva

Trasformazioni di gauge La carica si conserva

Sogni infranti

La simmetria può essere rotta.

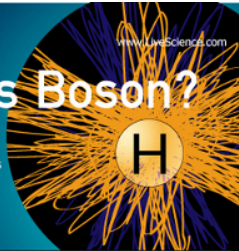


Bosone di Higgs

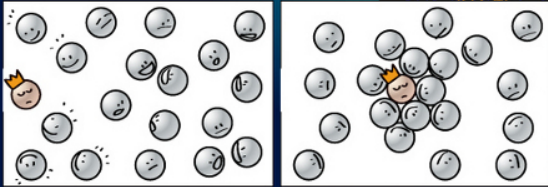
 www.LiveScience.com

What is a Higgs Boson?

The elusive Higgs boson, if found, would complete the Standard Model of physics. It is thought that matter obtains mass by interacting with the Higgs field. If Higgs did not exist, according to the model, everything in the universe would be massless.



The "cocktail party" analogy



Imagine a party where guests are evenly spaced around the room. The room of guests represents the Higgs field, which is everywhere in the universe. Suddenly a celebrity enters. Guests notice the celebrity and rush in closer to be near her, forming a tight knot.

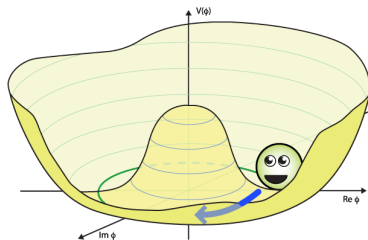
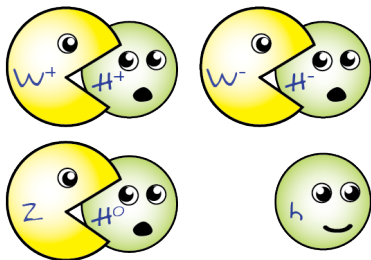
As the celebrity passes through the room, the concentrated clump of guests surrounding her gives the group additional momentum. The clump is harder to stop than one guest alone would be, and so we can say that the clump has acquired mass.

SOURCE: CERN

KARL TATE / © LiveScience.com

Bosone di Higgs

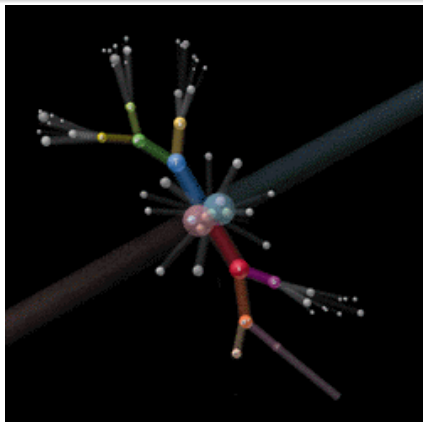
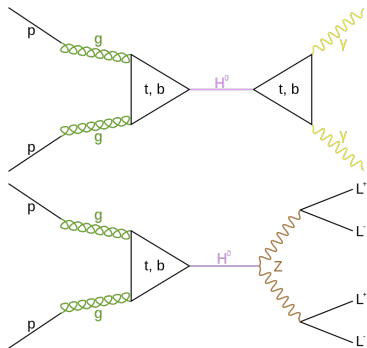
I bosoni $W^\pm$ e Z^0 e i fermioni “mangiano” un bosone di Higgs e prendono massa.



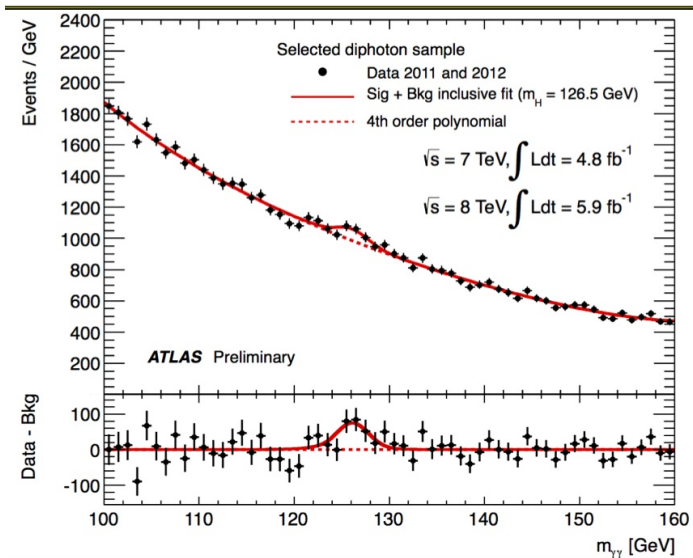
I fotoni (e i gluoni) non si legano all'Higgs e restano massless.

La vera formula di Einstein

$$E^2 = m^2 c^4 + p^2 c^2$$



Quanto è difficile?



A cosa serve?

Non lo so, ma scommetto che un giorno il governo ci metterà sopra una tassa.

Faraday - 1832

Pastore *Esiste in prospettiva, connessa con questo acceleratore, una qualsiasi cosa che sia in qualche modo vantaggiosa per la sicurezza di questa nazione?*

Wilson *No signore. Non credo.*

Pastore *Nulla di nulla?*

Wilson *Nulla di nulla.*

Pastore *Non è di alcun valore, al rispetto?*

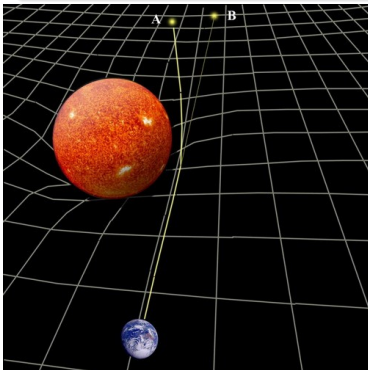
Wilson *È vantaggiosa per il rispetto che portiamo gli uni agli altri, la dignità dell'uomo e il nostro amore per la cultura. [...] Non ha niente a che fare direttamente con la difesa nazionale, a parte rendere il nostro paese degno di essere difeso.*

- 1957 Lee e Yang: violazione della parità
- 1965 Feynman, Schwinger e Tomonaga: QED
- 1969 Gell-Mann: quark
- 1979 Glashow, Salam e Weinberg: forza Elettrodebole
- 1982 Wilson: gruppo di rinormalizzazione
- 1984 Rubbia e Van der Meer: bosoni W e Z
- 1988 Lederman, Schwartz e Steinberg: neutrino muonico
- 1990 Taylor, Friedman e Kendall: struttura del protone
- 1995 Perl e Reines: τ e ν
- 1999 't Hooft e Veltman: rinormalizzazione dimensionale
- 2004 Gross, Politzer e Wilczek: libertà asintotica e confinamento
- 2008 Kobayashi, Maskawa e Nambu: rottura di simmetria
- 2013 Englert e Higgs: massa delle particelle

Cosa manca? Gravità

Il sogno di Einstein

La relatività generale è incompatibile con il modello standard.



Cosa manca? Come mettere insieme i pezzi

Supersimmetria Nessuno l'ha mai vista.

Teoria delle stringhe Servono 10 dimensioni!



Cosa manca? Materia oscura

Le galassie ruotano in modo strano (troppo veloce ai bordi)

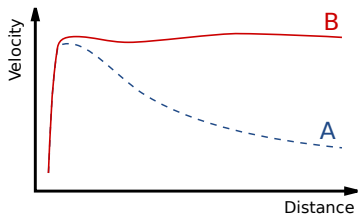


Immagine APOD - M51

Cosa manca? Materia oscura

C'è materia non visibile (non interagisce con i fotoni)

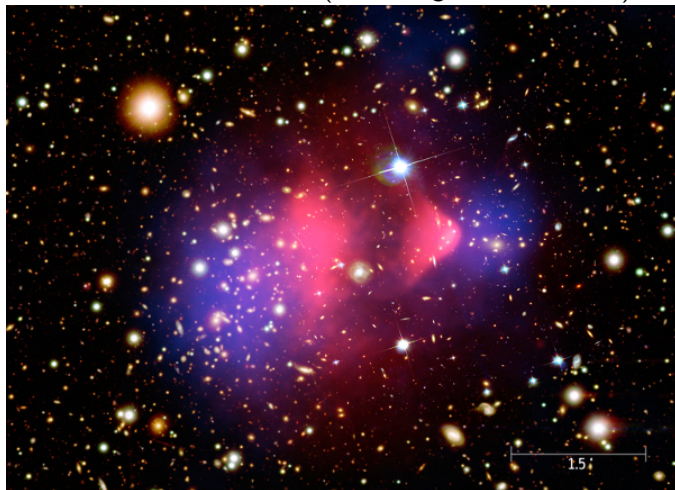


Immagine APOD - Bullet Galaxy

Cosa manca? Energia oscura

L'universo si espande e l'espansione accelera!

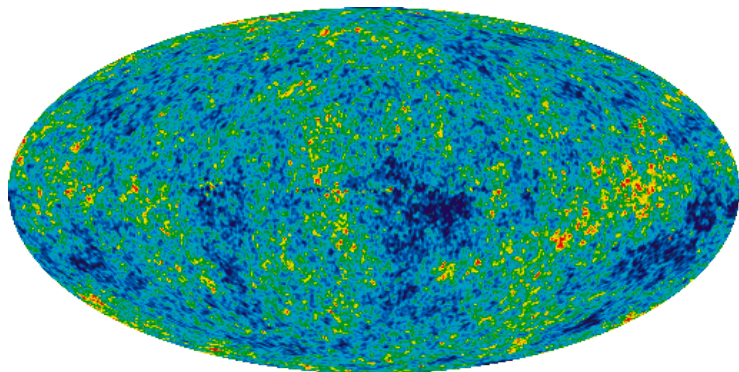


Immagine APOD - CMB

Cosa manca? L'inizio

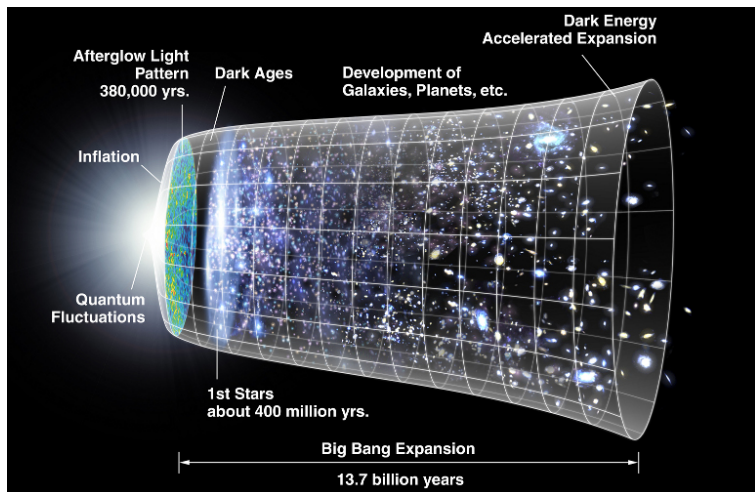
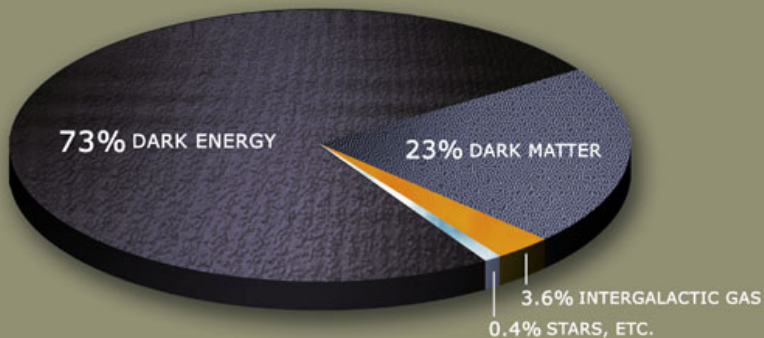


Immagine Wikipedia

Cosa manca?

Non conosciamo il 95% dell'universo!



Thank you!