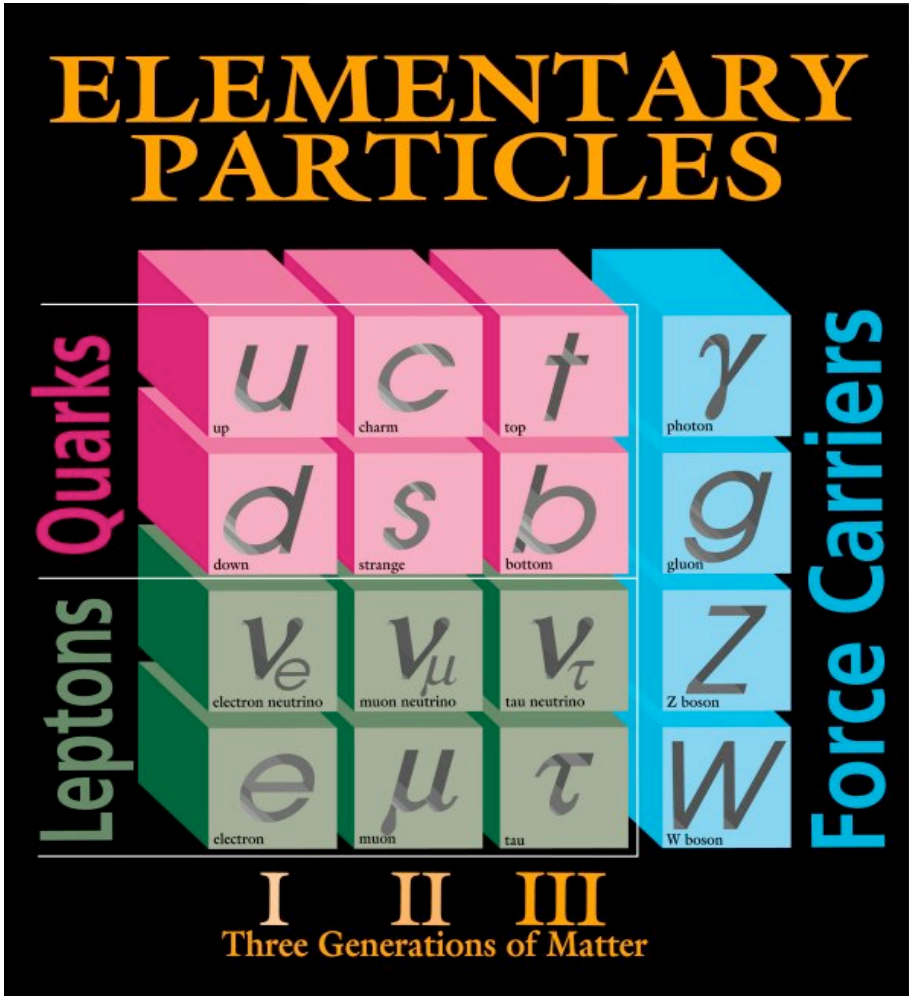
The standard model



Gigi.Rolandi@cern.ch

Leptons (1)

There are six leptons classified according to their electric charge, electron number, muon number an tau number . They fall in three generations (or sometime families).

LEPTON CLASSIFICATION

	l	Q	L_e	L_μ	L_τ
First generation	e	−1	1	0	0
	ν_e	0	1	0	0
Second generation	μ	−1	0	1	0
	ν_μ	0	0	1	0
Third generation	τ	−1	0	0	1
	ν_τ	0	0	0	1

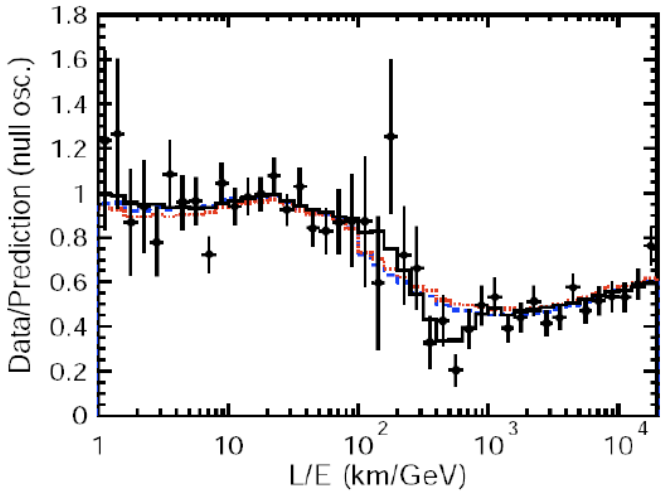
Leptons (II)

The mass of the charged leptons are ~ 0.51 MeV, 105 MeV and 1777 MeV

Their $c\tau$ are ∞ , 659 m and 87 μm

Direct limit on neutrino masses $m(\nu_e)$ < few eV (Tritium decay)
$m(\nu_\mu)$ < 170 keV (pion decay)
$m(\nu_\tau)$ < 18.2 MeV (tau decay)

Neutrinos however have a finite mass since they oscillate

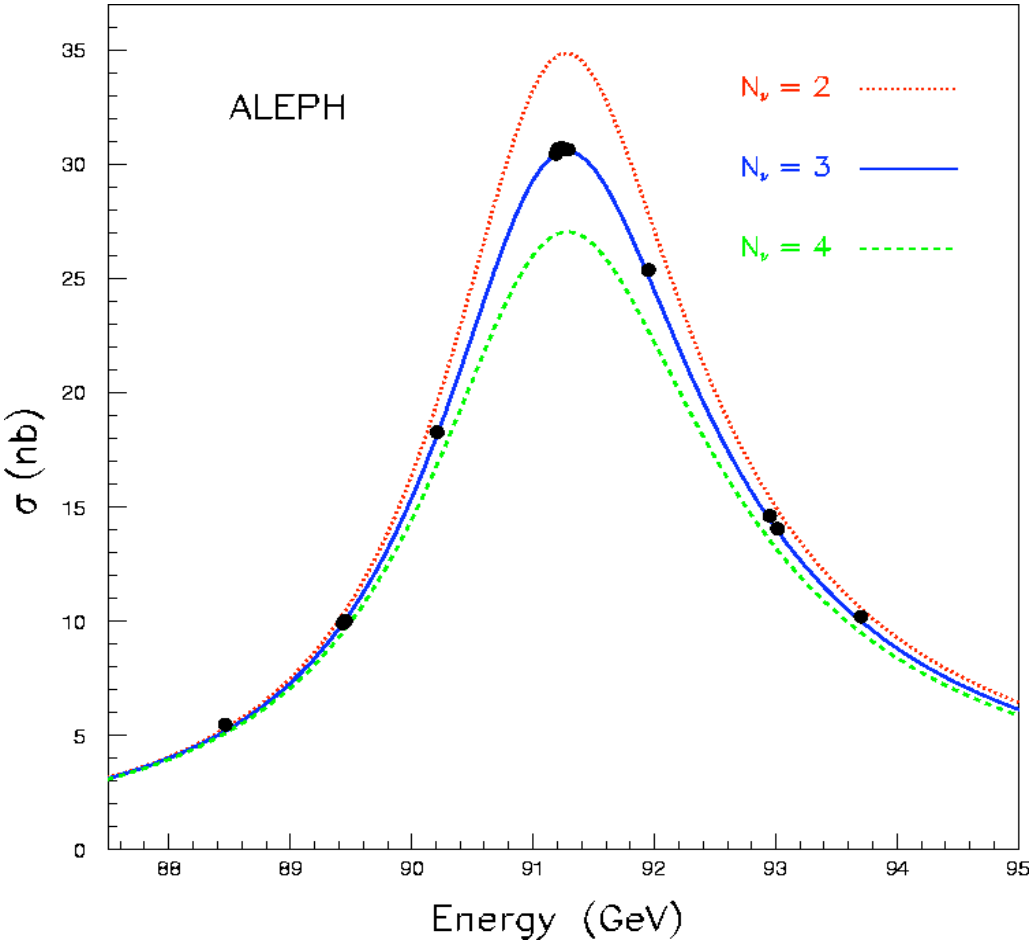


Superkamiokande

$$\sqrt{\Delta m^2_{21}} \sim 0.009 \cdot eV$$

$$\sqrt{\Delta m^2_{32}} \sim 0.04 \cdot eV$$

Solo tre tipi di neutrini leggeri



$$\sigma_f^{peak} = \frac{12\pi}{M_Z^2}\frac{\Gamma_{ee}\Gamma_f}{\Gamma_Z^2}(1-\delta_{rad}) \equiv \sigma_f^0(1-\delta_{rad}),$$

$$\Gamma_Z = N_\nu\Gamma_\nu + 3\Gamma_{ee} + \Gamma_{had},$$

Quarks(1)

There are six quarks classified according to their electric charge, strangeness (S), charm (C) , beauty (B) and truth (T). They fall in three generations (or sometime families).

QUARK CLASSIFICATION

	q	Q	D	U	S	C	B	T
First generation	d	$-\frac{1}{3}$	−1	0	0	0	0	0
	u	$\frac{2}{3}$	0	1	0	0	0	0
Second generation	s	$-\frac{1}{3}$	0	0	−1	0	0	0
	c	$\frac{2}{3}$	0	0	0	1	0	0
Third generation	b	$-\frac{1}{3}$	0	0	0	0	−1	0
	t	$\frac{2}{3}$	0	0	0	0	0	1

Quarks(2)

The masses of the quarks are not a well defined concept because they are colored and are not experimentally detectable as a single particle. However they can be defined coherently in a theoretical framework.

m(u) ~ 2 MeV m(d) ~ 5 MeV m(s)~ 100 MeV

m(c) ~ 1.2 GeV m(b) ~ 4.2 GeV m(t) ~ 170 GeV

m= 0.1 GeV → $\tau \sim 10^{-6}$ s
m= 2 GeV → $\tau \sim 10^{-12}$ s
m=170 GeV → $\tau \sim 10^{-22}$ s

$$\tau = \frac{192\pi^3\hbar^7}{G^2 m_\mu^5 c^4}$$

Warning, very qualitative, : no final states counting , no CKM

Quarks (3)

Quarks carry a color charge (three colors) and only colorless particle exist free in nature. Mesons are made by a pair of quark-antiquark of opposite color and barions are made by a quark (or anti-quark) triplet.

They interact exchanging gluons (8 types of gluons carrying also a color charge) which keep the hadron in the bound state. Since hadrons are composite states they exist also in exited states.