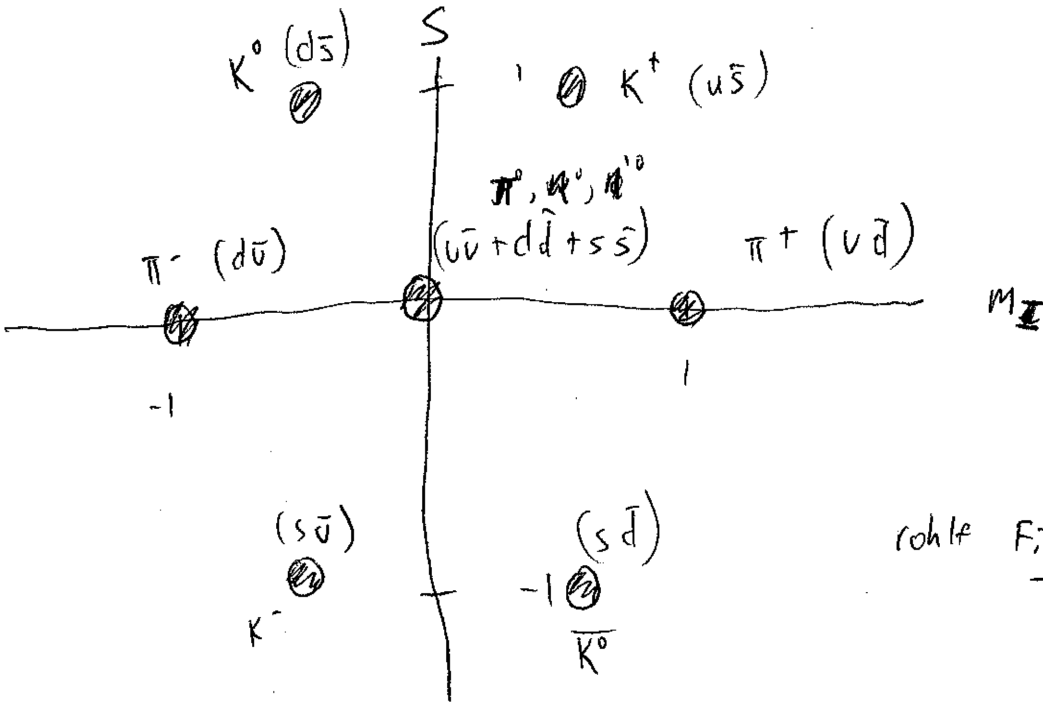
Mesons

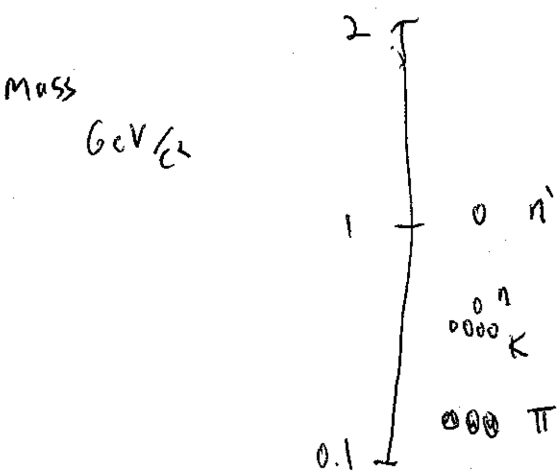
$j^P = 0^-$



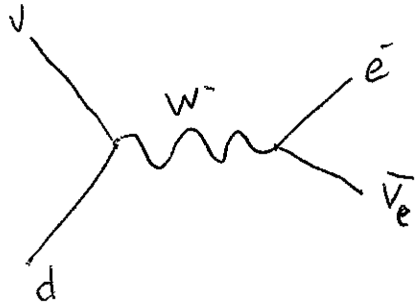
rohlf Fig 17-8

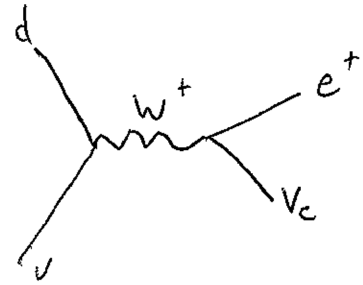
Isospin

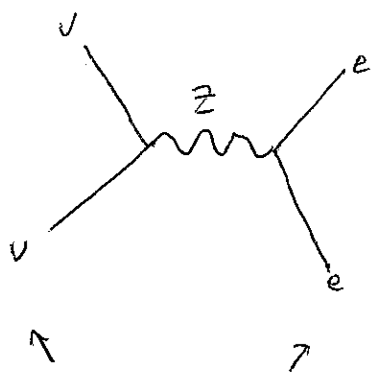
	I	m_I
u	$\frac{1}{2}$	$\frac{1}{2}$
d	$\frac{1}{2}$	$-\frac{1}{2}$
s	0	0



weak interactions involve exchange of W^-, W^+, or Z^0 Bosons

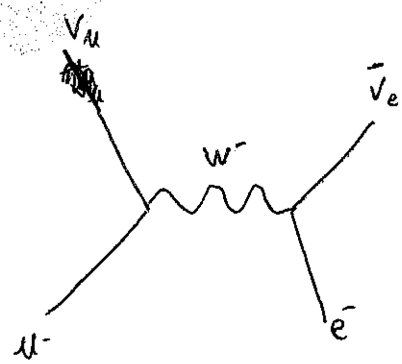






any quark or lepton

muon decay by weak interaction



QCD

Quantum Chromodynamics

quarks can have 3 "colors" R, G, B

Only color neutral particles are allowed

needed to explain particles like

$\Omega^- = sss$

mesons have color - anticolor quarks to be color neutral

color charged particles interact by exchanging gluons

Other evidence for 3 colors

$e^+ + e^- \rightarrow \mu^+ + \mu^-$

$\rightarrow \bar{q} + q$

The relative rate, or cross section is

$$\sigma_{\bar{q}q} = \left(\frac{q_q}{e}\right)^2 \sigma_{\mu\mu^+}$$

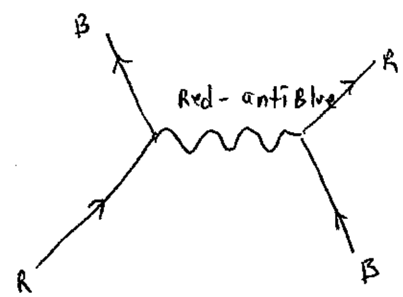
$$\sigma_{hadron} = \sum \sigma_{\bar{q}q}$$

degeneracy of 3 for collors gives experimentally observed value, gluons

Carry color charge

can convert to $q\bar{q}$ pairs $g \leftrightarrow q\bar{q}$

Carry color-anticolor pairs



Some modern physics mysteries

Particle Mass - why do particles have mass, and the particular value of mass observed?

One explanation:

Particles couple to a "Higgs" field

The lowest energy state of Higgs field is not zero,

particles gain mass by interacting with the Higgs field,

There is a quantum of the field - the "Higgs Boson"

If standard model is correct to planck scale (10^{16} TeV)

M_{H^0} is 130 - 190 GeV.

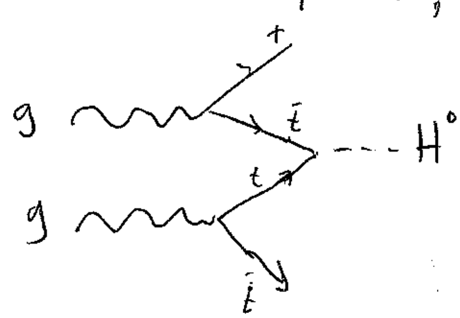
experiments give lower bound of 115 GeV

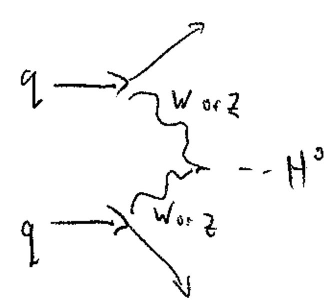
Expected to be observed at LHC. Large Hadron Collider

p → ← p

7 TeV 7 TeV

One possible creation process, another:





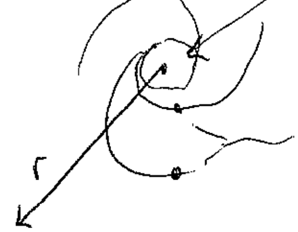
Dark Matter and Dark Energy

Mass- Energy Distribution in the Universe

Dark Matter	23 %	96% unknown
Dark Energy	73 %	
Stars	0.4 %	
Intergalactic Gas	3.6 %	

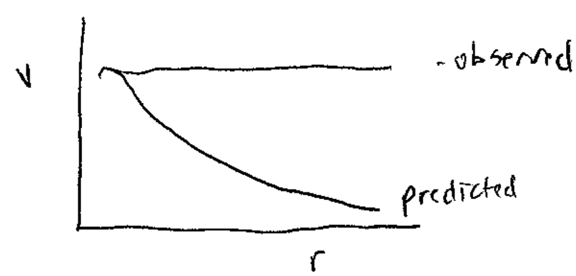
Evidence of Dark Matter

Spiral Galaxy



most observed mass is in the center

orbital velocity of stars should be $v \sim \frac{1}{\sqrt{r}}$



what is it?

Neutrinos have too small of mass to account for missing mass

most promissing: Cold Dark Matter (CDM)

WIMPs : Weakly interacting Massive Particles - some unknown particle

MACHOs : Massive Compact Halo objects - neutron stars, black holes, ...

Dork Energy

Dork Energy is postulated to explain the observation of accellerating expantion of the Universe.

Cosmological constant, Λ : A volume of space has intrinsic energy.

This effect can be easily added to General Relativity.

Quantum field theories predict Λ to be 10^{120} too large.