Standard Model

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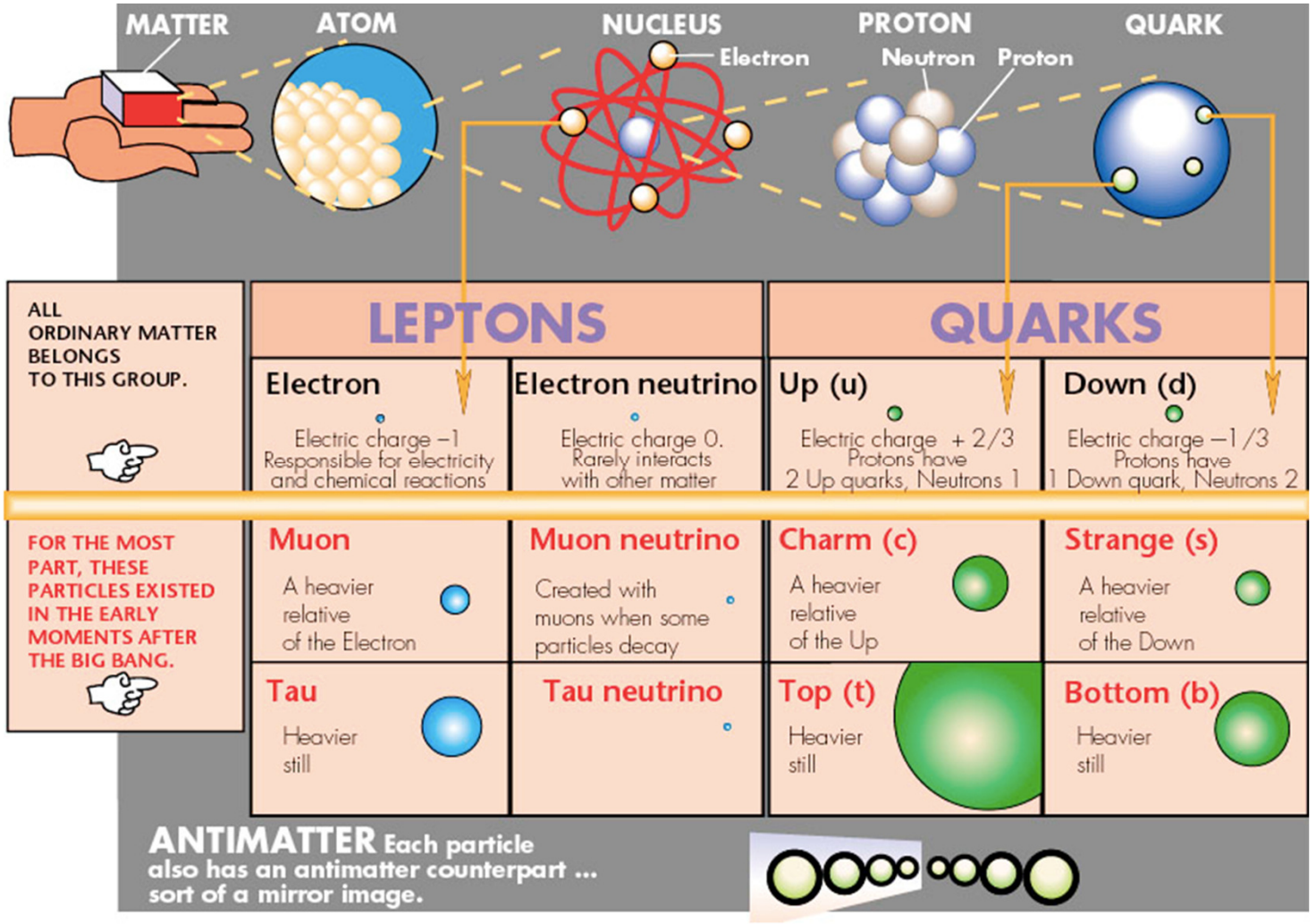
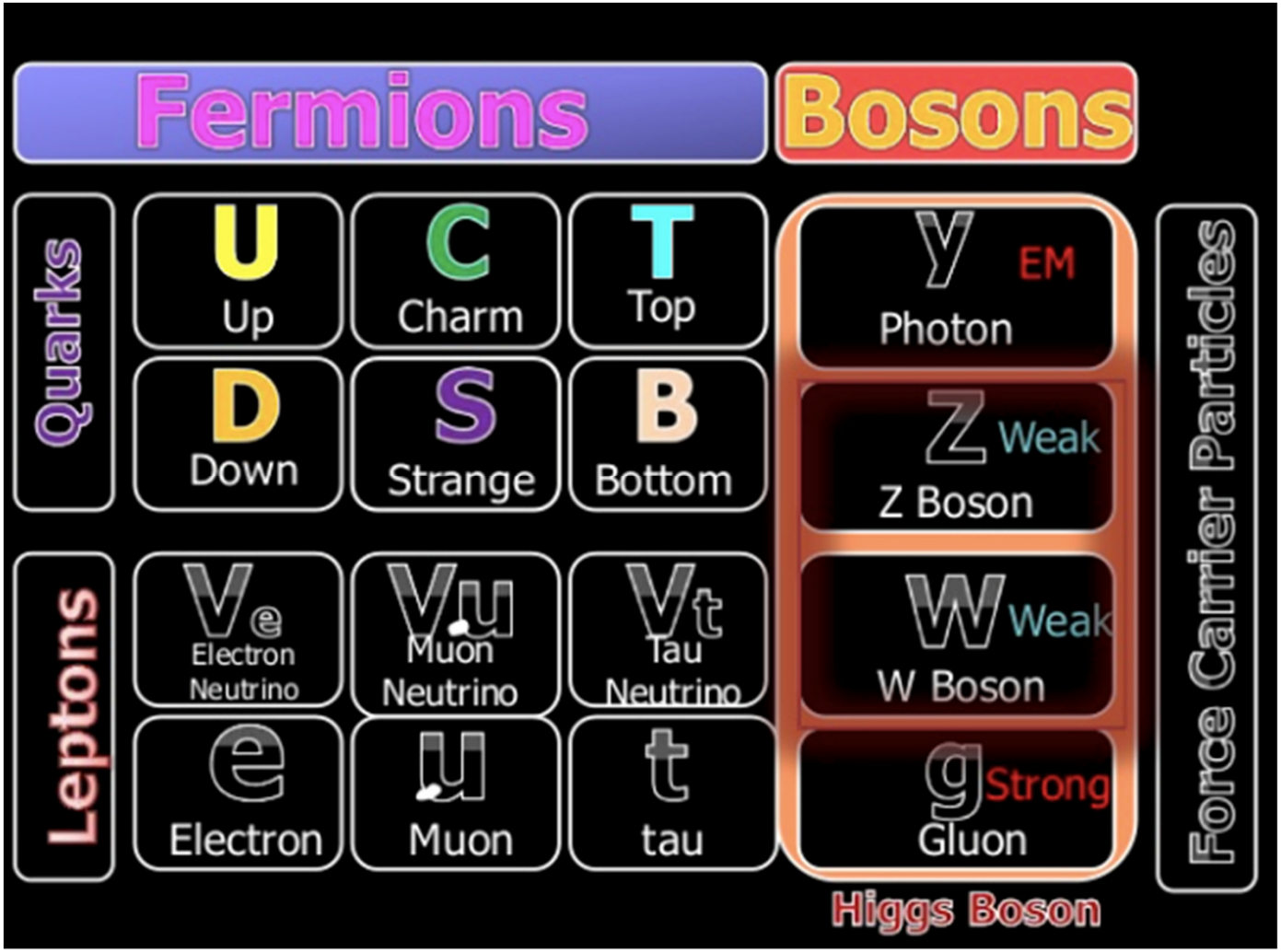
What it is?

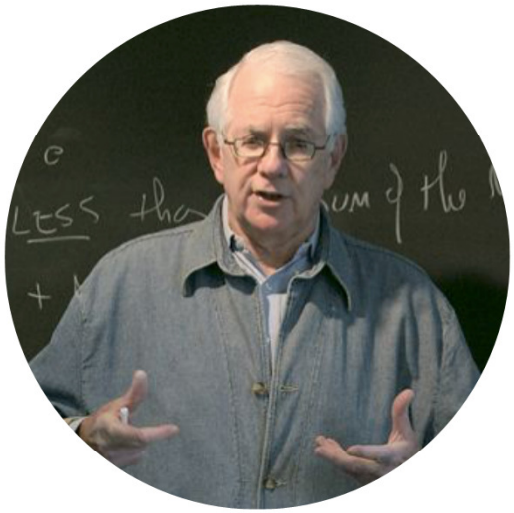
- Theory of particle physics
- Standard model classifyes all known elementary particles and describes three out of four fundametal forces. (electromagnetic, strong and weak force)
- It's not the theory of everything because the gravity doesn't belong to it.

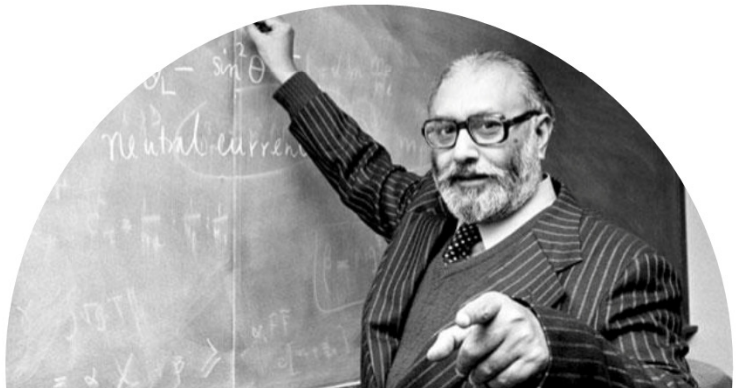

MATTER
ATOM
NUCLEUS
Electron
PROTON
Neutron
Proton
QUARK
ALL ORDINARY MATTER BELONGS TO THIS GROUP.
LEPTONS
QUARKS
Electron
Electric charge −1
Responsible for electricity and chemical reactions
Electron neutrino
Electric charge 0.
Rarely interacts with other matter
Up (u)
Electric charge + 2/3
Protons have 2 Up quarks, Neutrons 1
Down (d)
Electric charge −1/3
Protons have 1 Down quark, Neutrons 2
FOR THE MOST PART, THESE PARTICLES EXISTED IN THE EARLY MOMENTS AFTER THE BIG BANG.
Muon
A heavier relative of the Electron
Muon neutrino
Created with muons when some particles decay
Charm (c)
A heavier relative of the Up
Strange (s)
A heavier relative of the Down
Tau
Heavier still
Tau neutrino
Top (t)
Heavier still
Bottom (b)
Heavier still
ANTIMATTER Each particle also has an antimatter counterpart ... sort of a mirror image.

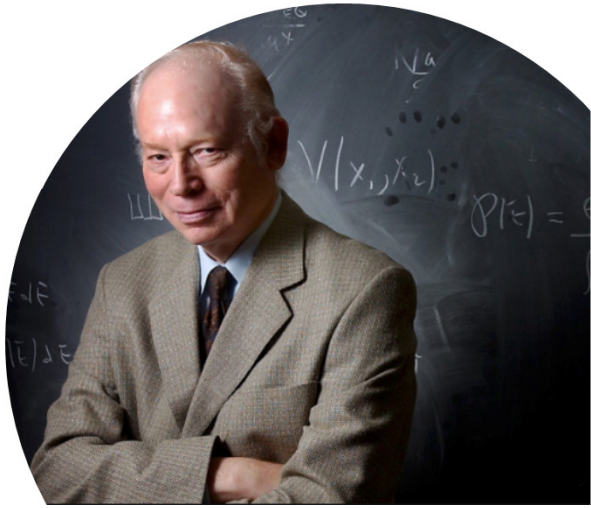

Fermions
Bosons
Quarks
U
Up
C
Charm
T
Top
D
Down
S
Strange
B
Bottom
Leptons
Ve
Electron Neutrino
Vu
Muon Neutrino
Vt
Tau Neutrino
e
Electron
u
Muon
t
tau
γ EM
Photon
Z Weak
Z Boson
W Weak
W Boson
g Strong
Gluon
Higgs Boson
Force Carrier Particles

History

- Developed from 1970-1973
- First steps were taken in 1961 when Sheldon Glashow discovered a way to combine the electromagnetic and weak interactions.
- Glashow's electroweak interaction got it's modern form when Steven Weinberg and Abdus Salam untited the **Higgs mechanism** into it.
- Z-boson was discovered in CERN in 1973.
- Abraham Pais and Sam Treiman created the name "Standard Model" in 1975







Higgs Boson

- Why particles have their masses is explained by **the Higgs field**.
- The field is thought to slow down the particles that would otherwise move at the light speed.
- The more forcefully the Higgs field influences the particle the larger one is the mass of the particle.
- This model forecasts the particle called **Higgs boson**.
- The newest

Fundamental particles

- Matter consists of fundamental particles called quarks and leptons.
- They don't have internal structure because they are the smallest part of the matter.
- The nucleus of the atom consists of quarks and electron is the lepton.
- Quark does never occure alone but they always form some kind of particle together - "inprisonment of quarks"
- Every particle has their anti-particle which has the same mass than the particle but the other qualitys are different like the charge. For example electron's anti-particle is the positron.

The families of the fundamental particles

- The fundamental particles are divided into three different families:
  - **Electron's family**: Up and Down quarks, electron and electron's neutrino
  - **Myon's family**: Charm and Strange quarks, myon and myon's neutrino
  - **Tau's family**: Truth or Top quark, Beauty or Bottom quark, tau and tau's neutrino
- All visible matter consists of particles of the family of electron.

Fundamental interactions

- There are four fundamental interactions known to exist: the gravitational and electromagnetic interactions and the strong and weak interactions
- Govern how objects or particles interact and how certain particles decay
- The interactions that do not appear to be reducible to more basic interactions

The Strong Force

- A Force which can hold a nucleus together against the enormous forces of repulsion of the protons
- Not an inverse square force like the electromagnetic force
- In the standard model, the basic exchange particle is the gluon which meditates the forces between quarks
- The strongest of the four fundamental forces

The Electromagnetic Force

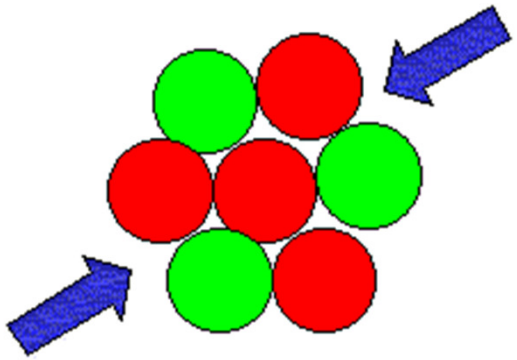
- Manifests itself through the forces between charges and the magnetic force
- Explains the chemical behavior of matter and the properties of light

The weak force

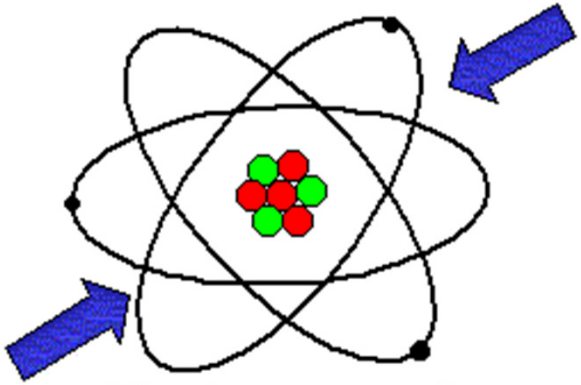
- Only effective at very short distances
- It acts on the subatomic level and plays a crucial role in powering stars and creating elements
- It is also responsible for much of the natural radiation present in the universe

Gauge boson

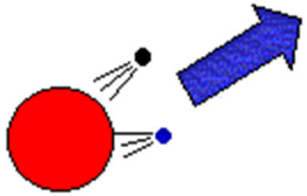
- It is a force-carrying elementary particle that carries any of the fundamental interactions of nature
- Elementary particles interact with each other by the exchange of gauge bosons
- All known gauge bosons are vector bosons
- The Standard Model of particle physics recognizes four kinds of gauge bosons: photons, W and Z bosons and gluons.



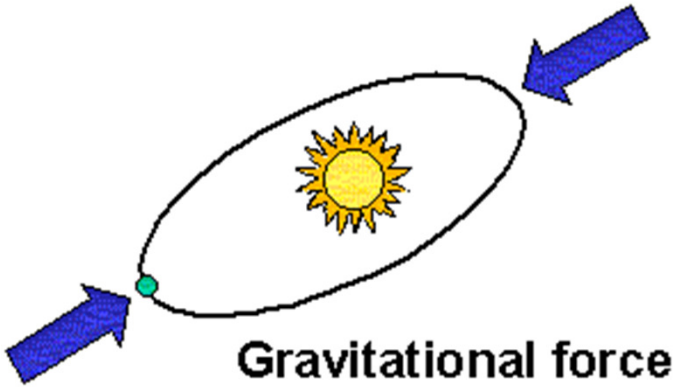
Strong force
binds the nucleus



Electromagnetic
force binds atoms



Weak force in
radioactive decay



Gravitational force
binds the solar system

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