ADDITIONAL ADVANCED PARTICLES PHYSICS CONCEPTS

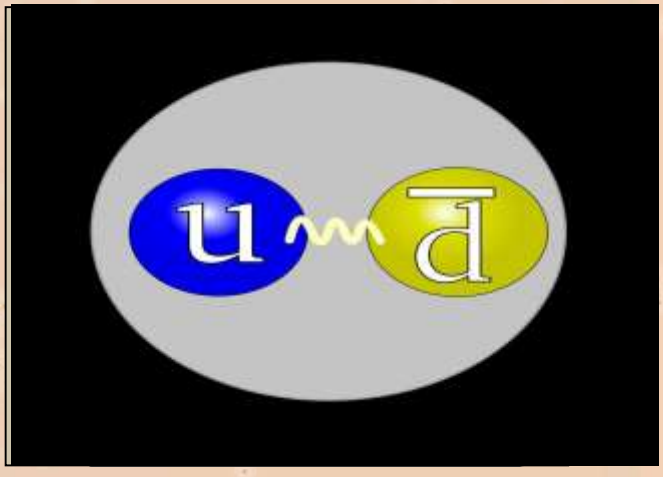
By group 6

no.203.078

Hideki Yukawa Particle

- Hideki Yukawa was a Japanese theoretical physicist..
- He was interested in strong nuclear force.
- In 1935, He proposed the existence of new particle .
- which is called the Meson, in order to explain in how proton and neutron in nucleus interact..
- Also, he proposed that force is transmitted by carrier particles- particles that give rises to forces between other particles..

Theory of meson



- The strong nuclear force is transmitted within the nucleus between protons and neutrons so, the force needs carrier particle to transfer.
- Pion are carrier which is not observable but there effect can observable that's the reason pion are virtual carrier.
- The force carrier has a finite mass this means it has a lifetime and decay into other sub-atomic particles.

Meson

- Yukawa's particles are called pi mesons or pins
- They are subatomic particle that are the lightest Meson also the lightest Hadrons.
- They feel strong nuclear force mainly.
- They are produced by natural processes when high energy cosmic ray protons and other hadronic cosmic-ray components interact with matter in Earth's atmosphere

Heisenberg's uncertainty principle

Yukawa's particle principle

- This principle formulated by a German Physicist Werner Heisenberg in 1927.
- It states that, it is impossible to determine the accurate value of pairs of quantum variables such as momentum and position, simultaneously

Recap on the four basic forces

There are 4 fundamental forces exist in the universe.

These all forces exchange A force carrier and affect all matters.

Those are :-

1. Gravity
2. Electromagnetism
3. The strong nuclear force
4. The weak nuclear force

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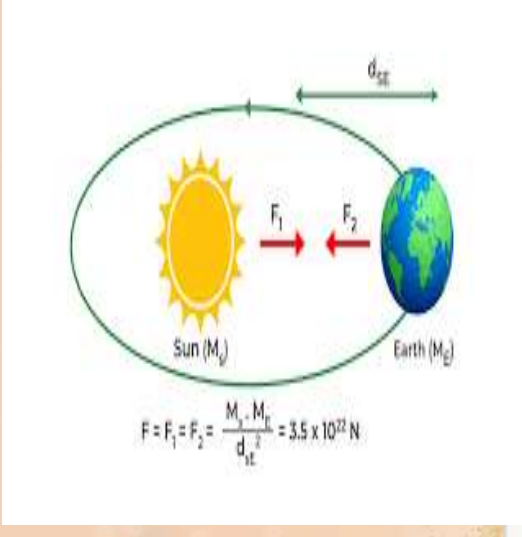
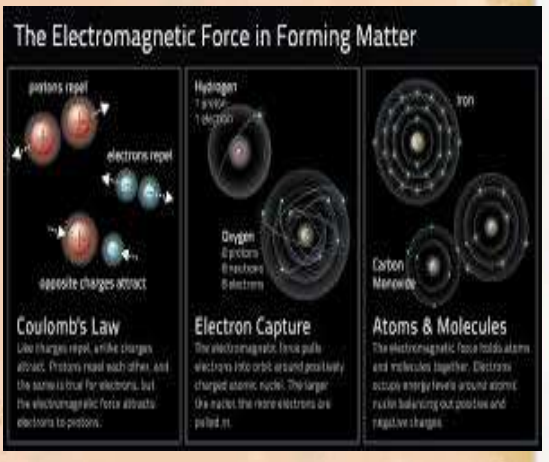
Gravity

- The idea of gravity proposed by Isaac newton.
- Gravity is an attractive force that draws two objects together.
- It acts on all particles including the mass less photon and the force carrier is graviton.
- It depends on object's mass and distance of separation, but it acts at infinity.(newton law of gravity)



Electromagnetism

- The electromagnetic force, given scientific definition by James Clerk Maxwell.
- It consists of electric and magnetic force and the force carrier particle is the mass less photon.
- It is stronger than gravity.
- Like gravity it is inversely proportion to square distance between the charges.
- Large objects are balanced by neutral atoms(equal number of protons and electrons).

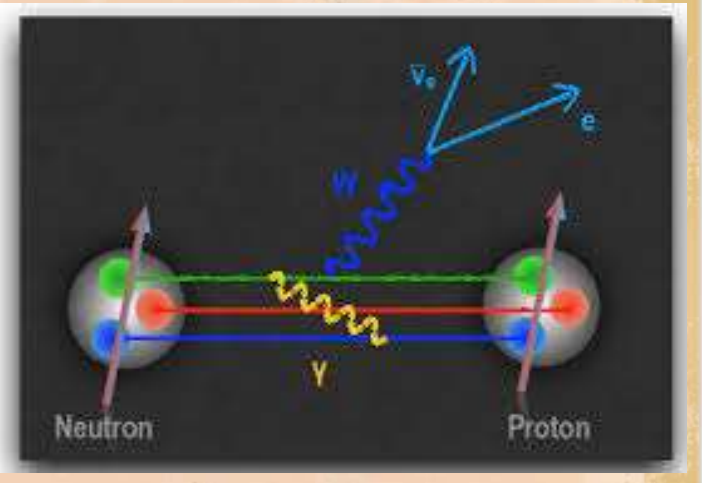


Strong nuclear force

- The strong nuclear force is an attractive force that exists n all nucleons.
- It acts on quarks (color charged particles) but leptons can’t feel.
- It holds quarks together to form hadrons.
- It is the strongest force of all forces and the force carrier particle is Pi mesons or pion (now known as gluons).

Weak nuclear force

- The Weak Nuclear Force acts on quarks and leptons. The force carriers are W+, W− and Z^0 bosons.
- The Weak Nuclear Force is responsible for particle decay.



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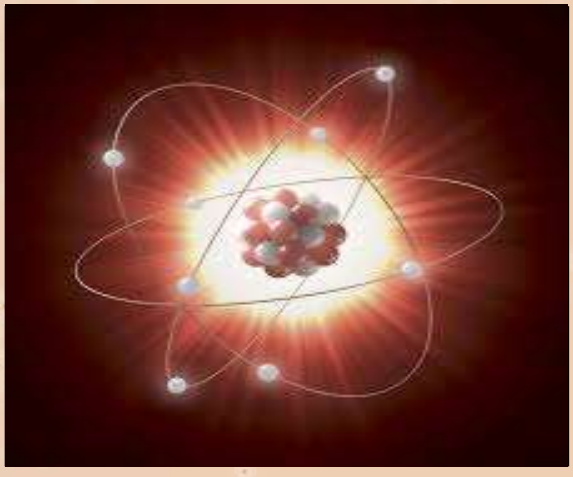
Matter



- Matter is a substance made up of various types of particles that occupies physical space and has inertia.
- Atoms are the building blocks of matter.
- Atoms and/or molecules in two or more elements can join together to form a compound. This compound, which is the basis of matters.
- Matter is composed of elementary particles called quarks and leptons

- Quarks – groups of subatomic particle that interact by means of a strong force – combine into protons and neutrons.
- Leptons – groups of subatomic particles that respond to weaker forces – belong to a class of elementary particles that includes electrons.

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Antimatter

- Some researchers have tried to identify why and they made a conclusion which they observed spontaneous transformations between particles and their antiparticles, occurring millions of times per second before they decay.
- Some unknown entity intervening in this process in the early universe could have caused these ”oscillating” particles to decay as matter more often than they decayed as antimatter

- Antimatter is composed of the antiparticles of the corresponding particles in matter.
- It can be thought of as matter with reversed charge, parity, and time, known as CPT reversal.
- When this things combine the will annihilate and collision will occur then all we have left with pure energy. But now days we don’t see antimatters as we see matters in our day to day life even if, their contact transforms to energy.

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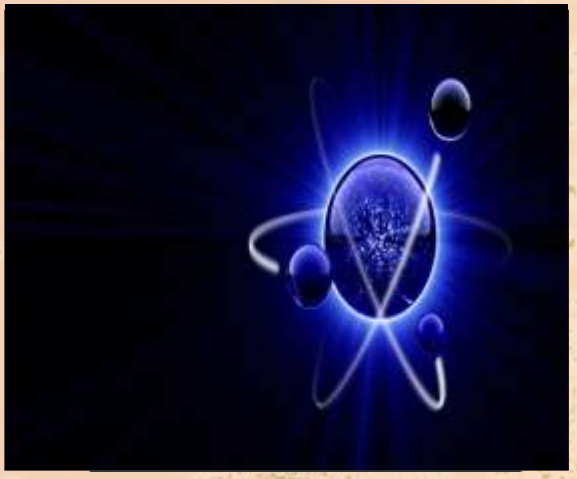
Quarks and matter

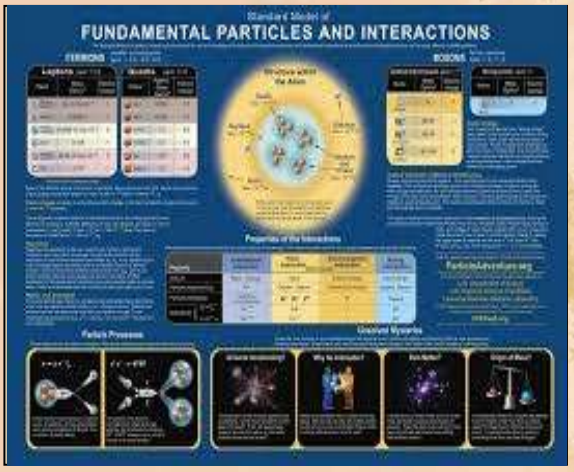


- The idea of quarks was proposed in 1964, and evidence of their existence was seen in experiments in 1968 at the Stanford Linear Accelerator Center (SLAC). The heaviest and last discovered quark was first observed at Fermilab in 1995.
- Quarks are the ultimate building blocks of visible matter in the universe.
- Quarks are elementary particles.
- Like the electron, they are not made up of any other particles.

- The Standard Model predicted 6 types of quarks: up, down, top, bottom, charm, and strange.
- They are differentiated based on properties such as mass and charge.
- The top quark is the heaviest one.
- Quarks are particles that create matter.

Grand Unified Theories - the Unification of Forces, Quantum Chromodynamics

- GUT is a theory in particle physics that merges the electromagnetic, weak, and strong forces into a single force at high energies.
- It describes the fundamental forces and the relation ship between elementary particles in terms of a single theory.
- It was identified that electric and magnetic forces are connected later at high energies, it was realized that the electromagnetic and weak forces are identical and called electroweak force..



- During the 1970s quantum field theory dedicated to the strong force known as quantum chromodynamics (QCD) was developed.
- QCD thestudy of the strong interaction between quarks takes place through the exchange of particles known as gluons.

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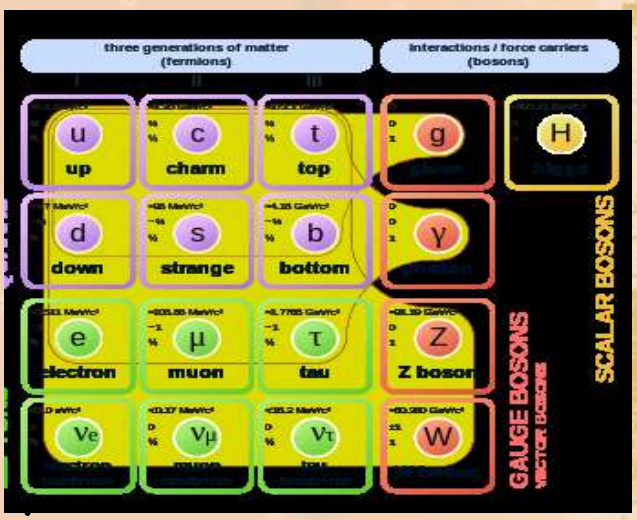
The Standard Model

- This theory describes strong, weak, electromagnetic forces but gravity. Quarks are the ultimate building blocks of visible matter in the universe.
- It tells us about how elementary particles join to form large particles and how they respond to the fundamental forces.
- there are three families of elementary particles which are leptons, quarks and bosons.



- The leptons and quarks are fermions, since they have a half integer spin.
- Bosons have a whole-integer spin..
- Neutrinos are the most abundant particles that have mass in the universe..
- Quarks are tiny particles that can't exist alone but when joined, they form hadrons.

RECAP

Previously we have tried to see about

- Yukawa particles
- Theory of meson
- Heisenberg's uncertainty principle
- The four basic forces
- Matter and antimatter
- Quarks and matter
- Grand Unified Theories
- Standard model

Thank you

THE END