1 | The Quantum World

- Atoms are small, and the quantum world concern itself with sub-atomic particles.
- In the 1920s, Protons and Electrons are know to be the two things that are subatomic
  - Protons are hitting earth frequently, creating the ”primary cosmic radiation”
- Photons also exists, but it has no mass
  - Protons were not given article status until later, when electrons are recognized also as being able to be created, anililated
- The 1920s brought a bunch of things
  - Matter, not just light, have wave-like properties
  - Fundimental laws of nature are on a probability curve
  - Electron spin was discovered
  - Antiparticle was discovered
- Importantly, the properties vs the action of the particles often get mixed up
- The known particles are mostly built from combination of smaller fundimental particals
- Standard model for Subatomic Particles
  - 24 subatomic particles

Fentometer (10^{-15} m) is the common unit of length. Speed of light, $3x10^8$ = C is the common unit for speed. e- charge as the common united as charge. eV, voltage of electron, is the common unit for energy.

A Tachyon *may* be able to travel faster than the speed of light. It is theoretical, may go faster than light, and could break causality in some reference frames. No one has found it.

- Gluon => Glue for particles within nucleaus
- Pion => nuclear collisions driven particle

1.1 | Absolutes

- Shortest distance: 10 * -18m
- Shortest time 10 * -26s
- Longest time: 13.7 billion years

Mass: measure of how hard it is to set a stationary object into motion, deflect, or stop a moving object.

So, to measure a particle’s mass, we boink it around in a magnetic field and measure its path.

#ask Kinetic energy + mass energy ($e=mc^2$) = energy?

”Mass energy is porportional to mass”. Mass represents a highly concentrated form of energy; a little mass yields lots of energy, meaning that a lot of energy is needed to make mass.

Humans have done this: if you take two protons and go kaboom by slaming them together, you put a lot of energy in, you make new mass!

Energy and mass are tipically measured in the same unit => the Electron Volt. And… MeV, is ”million electron volts.”

Like charges repel; but how does the necleaous stay together? Gluons — gluons serve as the glue to glue particles together. But, heavy elements have very high electrical force from change that cause things to fly away, so gluons work… to a point. This is why uranium+ atoms don’t exist in nature

Charge is measured in Coulomb => charge through a 100 watt light bulb in a second

Rotation around center: spin

Rotation around object: orbital motion

Both are measured by angular momentum => angular momentum is quantized by h-bar (Planck’s constant/2pi). Meaning particles could only have angular momentum 0, h-bar, 2h-bar, 3hbar, etc.

In theory, you spinning is also quantized like this, but you don’t notice it because… scales.

Natural constant: Planck’s Constant (h) & the speed of light (c).