***Quantum Particles / Particle Physics***

As far as we know about the quantum world, there are different types of particles and forces around us. The particles are divided into two categories which are **fermions** and **bosons**, and there are three fundamental forces around us not including gravity because it cannot be described in quantum mechanics. Fermions are normal particles while bosons are energy particles that work in carrying forces. Fermions are divided into two types: **quarks**, which feel nuclear force; **leptons**, which don’t feel any force.

At first, we have three basic, fundamental particles around us: **electron, proton and neutron**; electron being the first one to be discovered among all of the particles in quantum history. Until the 1960s, people thought that probably these three particles couldn’t be broken into smaller parts anymore. But later, scientists discovered that protons and neutrons were further made up of **up quarks** and **down quarks**; protons made of one down, two up quarks; neutrons made of one down, two up quarks. Along with these came the neutrino, also called the **electron neutrino**. It has a very little mass, almost 1 million times smaller in size than an electron. Neutrinos are extremely light and they are passing through our bodies every second.

So far, we discussed electron, up quark, down quark and electron neutrino.

Now, there are 2 more copies of these in the nature. The first copy includes **tau, top quark, bottom quark and tau neutrino**, while the second copy has **muon, charm quark, strange quark and muon neutrino**. But these two generations don’t really exist for a long time. They are created in nuclear explosions or fusions and they simply decay to their previous forms (the first generation) within a very short time. No one knows why there are three generations of these particles instead of any other number. Muons and taus are really just another form of electrons, except for the fact that muons are 200 times its size while taus are 350,000 times. There are also some **anti-particles** of these particles that we’ve mentioned, but they don’t have much contribution in the quantum physics.

Now, the four fundamental forces. Gravity, in quantum scale, is so weak that it cannot be described in quantum physics. So, the other three forces are the ones that work on these quantum particles. **Electromagnetism** is a force that acts on all the particles that have charge, electron-type particles and the quarks. The particles of electromagnetism are called **photons**. The next force is the **strong force** which bounds together the nucleus of an atom, the protons and neutrons. The particles of the strong force are called **gluons**, as it literally glues them together. The last force is the **weak force**, which has the ability to transform the identity of a particle. It can change up quarks to down quarks and vice versa, which can then change protons to neutrons and vice versa. When down quarks are turned into an up quark, it releases an electron and a neutrino. This process is called radioactive beta decay (β-decay). The particles for the weak force are **W-bosons and Z-bosons**. The weak force is the only force that works on all the particles, regardless of their charge. The last piece in our standard model of physics is the **Higgs-boson**. It’d be easier to just say that it gives mass to other particles like electrons and neutrinos. But we are still missing the boson-particle of gravity. Scientists are working on it and they named it **graviton**, though the sign of these were never experimentally found.