

Digging it deep- the fundamental idiosyncrasies of the Universe

I remember when I first studied the simplest atomic model that consists of electrons orbiting around the nucleus; I made the analogy of atom being a state. In that state, nucleus was the palace and it accommodated neutrons and protons where proton was the king and the neutron was the queen. The charge on the proton made him the king by the way. And the electrons were the servants or soldiers orbiting the palace for security and to get the orders, with such a little mass compared to the nucleus I was sure electrons were of a low rank. The wars between soldiers of different states were the chemical reactions and the atom who gained electron was the winner over the one who lost it. The transferred electron was supposed to be the slave in the other state and my story continued. 😊

Well, humans have been trying to find the smallest entity in the universe since the very beginning. Greeks for the first time gave the concept of atom. They regarded it as the smallest indivisible particle that was the fundamental unit of everything in the Universe. The idea was fascinating; humans had finally discovered what nature was all about, only that it was wrong. Rutherford bombarded atom with alpha particles and a whole new story of the nucleus, protons and neutrons came out. He himself was shocked after his experiment for there was a long period of time when all the brilliant minds of science were sure that atom was the smallest particle and was indivisible.

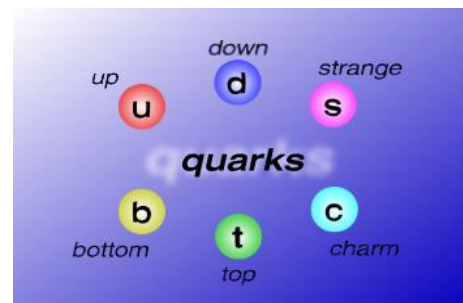
"...It was quite the most incredible event that ever happened to me in my life. It was almost as incredible as if you fired a 15.inch shell at a piece of tissue paper and it came back and it you..."

Rutherford, 1936

So, discoveries led to the idea that atom was divisible with nucleus at the centre and negative charges revolving around and then protons, electrons and neutrons were considered to be the fundamental particles of the atom.

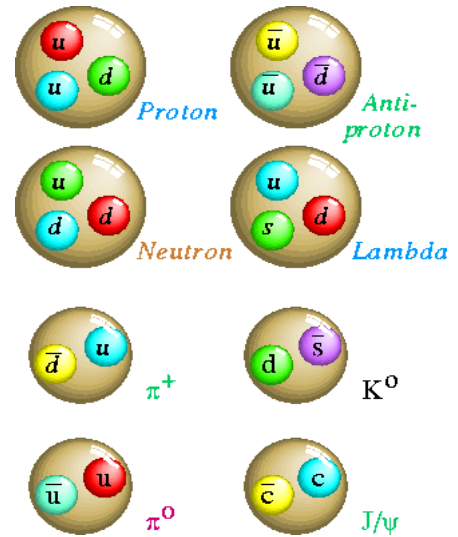
We spent an age believing this...

In 1963, Gell-Mann and American physicist George Zweig independently postulated the existence of the quark- an even more fundamental elementary particle with a fractional electric charge. Quarks are confined in protons, neutrons, and other particles by forces associated with the exchange of gluons. It was discovered that protons and neutrons were not dimensionless fundamental points rather they were fuzzy ball like objects having some internal structure. Deep inelastic scattering experiment showed that protons contained smaller point like objects. In this experiment, electrons were fired at protons and neutrons in atomic nuclei. When an electron emerged from the nucleus its trajectory and velocity was detected. It was found out that baryons had three points of deflection and mesons had two (once baryons and mesons were considered to be elementary. Baryon is a generic name for particles composed of three quarks, whereas mesons are a family of particles composed of one quark and one antiquark). Richard Feynman called this fundamental particle Parton



and Gell-Mann named it Quark later on. Quarks were termed as the elementary particles of every substance with no size no structure. Gell-Mann and others later constructed the quantum field theory of quarks and gluons called quantum chromo dynamics (QCD).

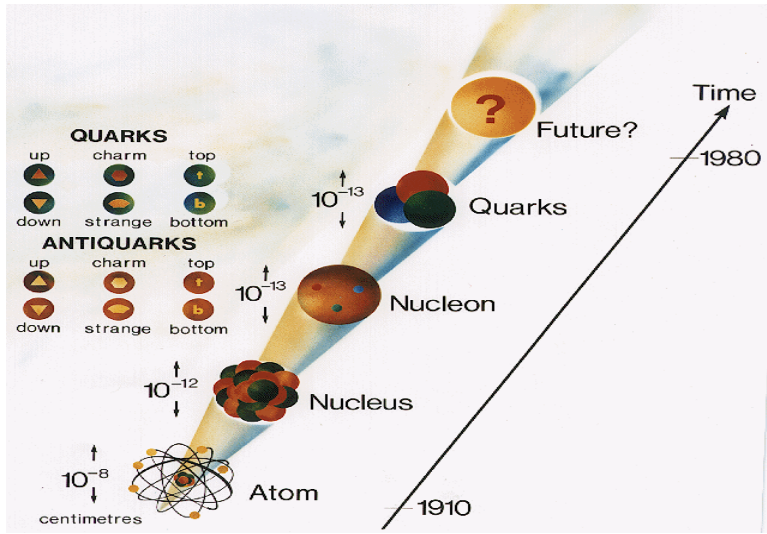
There have been discovered 6 quarks (up, down, strange, charm, top and bottom) and 6 leptons (electrons, muon, tau, electron-neutrino, muon-neutrino and tau-neutrino) and there are anti particles for all of them. So all in all there are 12 quarks and 12 leptons (quarks and leptons being different in the sense that leptons are not affected by the strong force while quarks experience all four fundamental forces of nature namely gravitation, electromagnetic force, the strong force and the weak force) making 24 particles in total that are considered to be the elementary structure of the universe, the building blocks of matter and hence, the basis of universal existence.



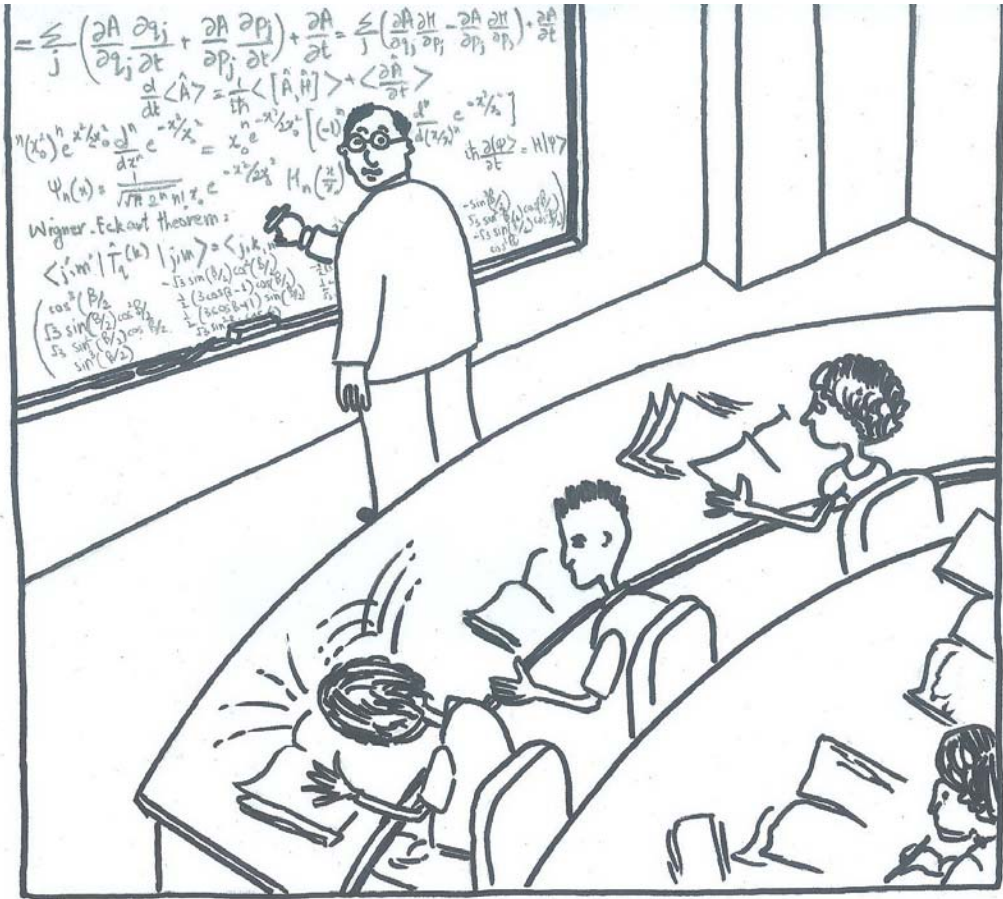
These quarks and leptons in different combinations make all the particles.

Now, we believe that everything in the Universe is to be made from twenty four basic building blocks called fundamental particles, governed by four fundamental forces. After this discovery maybe the search for the fundamental particle of the universe is complete. Or maybe like Rutherford we again come across a completely shocking experiment and it turns out that quarks and leptons are even composed of smaller particles, then how do we know if that's the end of it... How can we ever be sure that we have found out the smallest particle of the universe...? How do we know that this might not be an infinite regression...? Maybe this search is never going to an end. Maybe the journey we started from atoms and moved to nucleons and then to quarks will go on forever... Can we ever be certain that we have finally discovered the true smallest element...?

Indeed nature is playing a beautiful game!



And finally, here comes my comic... (This is not meant for a particular instructor..!☺)



THE INSTRUCTOR OF QUANTUM MECHANICS STOPPED WRITING
ON THE BOARD WHEN HE HEARD A LOUD THUD...
ANOTHER BRAIN IMPLoded!