

## God Particle

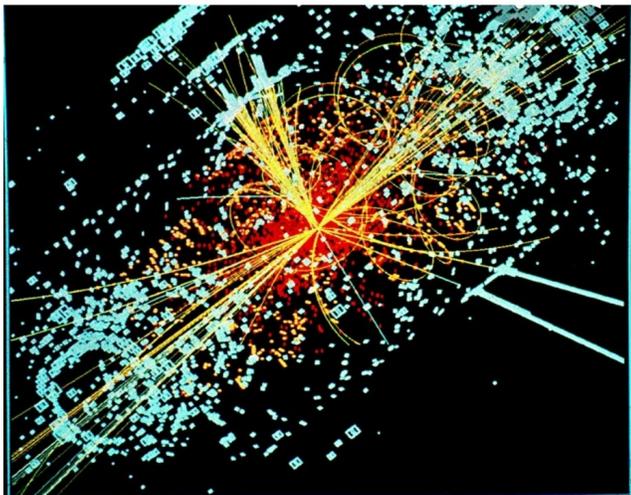
Promita Ghosh

Editorial Member – T.E.M.S Journal

### Abstract:-

This article is about the Higgs boson particle or the God particle (nick name).

During the year 2012, the God particle and LHC ( large hadron collider ) gain a lot of publicity and media attention for good. The Higgs boson is named that way because the scientists made fun of how hard it was to detect the particle and the level of hardship was god level. But this article isn't about the god particle detection or LHC, but some of the theoretical aspect of the god particle.



## Why God particle needed to be introduced?

The Standard model of subatomic particles was previously based on the symmetry of nature, but symmetry it means that under some types of transformation, the physical properties remains unchanged. By this phenomena differences is calculated a set of equation, for weak nuclear force and electromagnetism, together it is called electric force. But it was a major problem. What is symmetry the force carrying particles have to had no mass. That was valid electromagnetism, because Photon has zero mass. But the W and Z particles, the particles which causes weak interaction between the quarks and other subatomic fundamental particles required to have certain mass unlike photon. If W and Z particles had no mass, certain phenomenon like beta decay would happen at infinite rate and many other processes will have probabilities greater than one at certain condition. In other words, absurd things are predicted. And scientists calculated their mass around  $80-90 \text{ GeV}/c^2$ .

To solve this issue, in 1964, there were two papers submitted by two good scientists Brout & Englert and

Peter Higgs. The papers agreed to a solution which is a new mechanism, called a Brout-Englert- Higgs mechanism, it broke the law of symmetry in the electro-weak force. They introduced a new Quantum Field called Higgs field, the particles on interacting with which gets the mass. Though it was meant to explain only the mass of W and Z particles, physicists extended to other elementary particles.

Till now, we have discussed only about higgs field , but where is the Higgs particle? Actually, in quantum field theory, the elementary matter particle and the force carriers are considered as the manifestation of the respective quantum fields. So the particle associated with the Higgs field is called Higgs boson particle. The word boson because it's one of the boson particles, that follows bose-einstein statistics.

Now, according to quantum dynamic, empty vacuum isn't empty at all. Particles and respective anti particles always pop up for really short time and then annihilate each other. These particles and anti particles are the particles that are associated with different quantum fields. Now, as they

get popped up and vanishes, the average is zero because ultimately it turns zero but the process of creation and annihilation continues. As the average is zero, we call the expectation value of those fields are zero. But that's not the case for Higgs field. It has non zero expectation value and it's omnipresent.

As for the symmetry of the electro-weak force, it was symmetric at extreme hot temperature, just after big bang happened. Then, the energy associated with the expectation value of the Higgs field was smaller than the energy density of the new born universe, so W and Z were allowed to be massless and electro weak force held symmetry.

### **Now why photons don't interact with Higgs field?**

When any particle try to pass through the Higgs field, it's always attempt to travel at the speed of light which is the maximum speed. But the particles which contain something called hypercharge, there happens a constant exchange of hyper charges. The mechanism is something like donating the Hyper charges to the particle and then we're going away from the next moment from the both

side. It is lot more technical. This causes some type of momentum transfer so this hinders the motion and the particle slows down. This is case of the particle which interact with Higgs field. The photon and gluons on the other hand do not have hypercharge, so they don't interact with Higgs field. And it passes with  $3 \times 10^8$ .m/S as no transfer of momentum occurs.

**Reference:-**

Cern.home

Quora

Image:- Live science

T.E.M.S Journal