Higgs Essay

The Higgs Boson

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Abstract

The Higgs Boson had been spotted at the Large Hadron Collidor. The announcement was a bit cautious. A particle had been found, "consistent with the long-sought Higgs Boson". However there are question marks. Firstly, in the past year or so, a few five sigma results have just disappeared. The fifth force of Fermilab or the Gran Sasso superluminal neutrinos are examples. While we await a final verdict, we might ask, what if the finding is not that of the required Higgs, however improbable this may be? There are of course other models. One is illustrated in this essay.

On the 4th of July came the sensational announcement which had been awaited by Physicists for many many years. The Higgs Boson had been spotted at the Large Hadron Collidor, the 22 billion dollar accelerator outside Geneva. The announcement was a bit cautious. A particle had been found, "consistent with the long-sought Higgs Boson".

Such a particle had been predicted in the 1960s by Peter Higgs and independently others. This was considered to be the bedrock of the Standard Model of Particle Physics which had been worked out by Salam, Glashow, Weinberg and others, because it was required via a symmetry breaking mechanism to endow mass to all the particles in the universe. Ironically no mass estimate for the Higgs Boson itself was given.

This sensational discovery if reconfirmed would still not be the last brick in the Standard Model. There are loose ends. For example in this model the neutrino has no mass, but in the late nineties a small mass for the neutrino was determined. The exact value of the neutrino mass is not known though. There are a few other persisting problems.

However there are question marks. Firstly, in the past year or so, a few five sigma results have just disappeared. The fifth force of Fermilab or the Gran Sasso superluminal neutrinos are examples. Ian Low of Argonne National Laboratory and the Department of Physics and Astronomy at North Western University, Joseph Lykken of Fermi Lab and Gade Shaughnessy of the Department of Physics at the University of Wisconsin, Madison have determined that there are alternative possibilities which are also consistent with the CERN data (arXiv.org/abs/1207.1093). This determination is based on the fact that the Higgs is so short lived that we have to consider its decayed signature which may include pairs of photons or Z Bosons and so on. Unfortunately this decay pattern is not unique, given the data collected at CERN so far. It is now pointed out that a generic Higgs

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doublet or even a triplet are also consistent with the data. These would be particles with respectively spin 1/2 and spin 1. However the required Higgs should be spin less.

While we await a final verdict, we might ask, what if the finding is not that of the required Higgs, however improbable this may be? There are of course other models. For example the minimal super symmetric standard model. Or we could explain the generation of mass within the framework of a fuzzy non commutative spacetime (B.G. Sidharth, arXiv.org/1201.0915).

The point is that in this Non-Abelian gauge theory, the well known Lagrangian is given by (with usual notation)

$$L = i\bar{\psi}\gamma^{\mu}D_{\mu}\psi - \frac{1}{4}F^{\mu\nu}F_{\mu\nu} - m\bar{\psi}\psi \tag{0.1}$$

In (0.1) there is no invariant mass term for the field bosons. The well known remedy is to take instead of the gauge field, the field

$$W_{\mu} = A_{\mu} - \frac{1}{q}\partial_{\mu}\phi \tag{0.2}$$

The field W_{μ} now generates the mass in a self consistent manner via a Higgs mechanism. Infact the kinetic energy term

$$\frac{1}{2}|D_{\mu}\phi|^2, \tag{0.3}$$

where D_{μ} in (0.3) denotes the Gauge derivative , now becomes

$$|D_{\mu}\phi_0|^2 = q^2|W_{\mu}|^2|\phi_0|^2\,, \tag{0.4}$$

Equation (0.4) gives the mass in terms of the ground state ϕ_0.

This underlies the Higgs mechanism. It has been pointed out by the author that (0.3) and (0.4) can be replicated, if instead of the usual smooth spacetime we consider a non commutative spacetime.

In any case we await the next few years with considerable excitement.