Higgs-Like Particle due to Revised Quantum Electrodynamics

Bo Lehnert

Alfvén Laboratory, Royal Institute of Technology, SE-10044 Stockholm, Sweden. E-mail: Bo.Lehnert@ee.kth.se

A Higgs-like particle having zero net electric charge, zero spin, and a nonzero rest mass can be deduced from an earlier elaborated revised quantum electrodynamical theory which is based on linear symmetry breaking through a nonzero electric field divergence in the vacuum state. This special particle is obtained from a composite longitudinal solution based on a zero magnetic field strength and on a nonzero divergence but a vanishing curl of the electric field strength. The present theory further differs from that of the nonlinear spontaneously broken symmetry by Higgs, in which elementary particles obtain their masses through an interaction with the Higgs field. An experimental proof of the basic features of a Higgs-like particle thus supports the present theory, but does not for certain confirm the process which would generate massive particles through a Higgs field.

1 Introduction

As stated in a review by Quigg [1] among others, the Higgs boson is a particle of zero electric charge and nonzero rest mass. The magnitude of the mass is, however, so far not predicted by theory. Several authors and recently Garisto and Argawal [2] have further pointed out that this particle is a spin-zero boson.

In this investigation will be shown that a particle with such basic properties can be deduced from an earlier elaborated revised quantum electrodynamical theory [3], and the consequences of this will be further discussed here.

2 Steady Axisymmetric States of Revised Quantum Electrodynamics

For the field equations of the revised theory to be used in this context, reference is made to earlier detailed deductions [3]. The latter are based on a broken symmetry between the field strengths $\mathbf{E}$ and $\mathbf{B}$, through the introduction of a nonzero divergence $\operatorname{div}\mathbf{E} = \bar{\rho}/\varepsilon_0$ as being based on the quantum mechanical Zero Point Energy of the vacuum state. In a spherical frame (r, θ, φ) of reference in an axially symmetric steady state with $\partial/\partial\varphi = 0$ and $\partial/\partial t = 0$, this leads to a magnetic vector potential $\mathbf{A} = (0, 0, A)$ and a space charge current density $\mathbf{j} = (0, 0, C\bar{\rho})$ due to the source $\bar{\rho}$. Here $C = \pm c$ represents the two spin directions, with c standing for the velocity constant of light. Introducing the normalized radius $\rho = r/r_0$ with r_0 as a characteristic length, and the separable generating function

$$F(r, \theta) = CA - \phi = G_0 G(\rho, \theta) = G_0 R(\rho) \cdot T(\theta) \tag{1}$$

where ϕ is the electrostatic potential, this yields

$$CA = -(\sin\theta)^2 DF \tag{2}$$

$$\phi = -\left[1 + (\sin\theta)^2 D\right] F \tag{3}$$

$$\bar{\rho} = -\frac{\varepsilon_0}{r_0^2 \rho^2} D \left[1 + (\sin\theta)^2 D\right] F \tag{4}$$

with the operator

$$\begin{aligned} D &= D_\rho + D_\theta \\ D_\rho &= -\frac{\partial}{\partial\rho}\left(\rho^2 \frac{\partial}{\partial\rho}\right) \\ D_\theta &= -\frac{\partial^2}{\partial\theta^2} - \frac{\cos\theta}{\sin\theta}\frac{\partial}{\partial\theta}. \end{aligned} \tag{5}$$

The field strengths then become

$$\mathbf{B} = \operatorname{curl}\mathbf{A} = \operatorname{curl}\left[0, 0, -\frac{1}{C}(\sin\theta)^2 DF\right] \tag{6}$$

$$\mathbf{E} = -\nabla\phi = \nabla\left\{\left[1 + (\sin\theta)^2 D\right] F\right\} \tag{7}$$

for an elementary mode generated by a given function F determined by the radial and polar parts $R(\rho)$ and $T(\theta)$. Here $\operatorname{curl}\mathbf{E} = 0$.

As a first step we consider the convergence properties of R and the symmetry properties of T with respect to the equatorial plane $\theta = \pi/2$. There are four alternatives of which there is one with a divergent R at the origin $\rho = 0$ and with a T of top-bottom symmetry, thereby leading to a net integrated electric charge q_0 and magnetic moment M_0. The other three alternatives all lead to vanishing q_0 and M_0 [3], and we can here choose any of these. Then the local electric field and its divergence are still nonzero, whereas the net integrated electric charge vanishes.

As a second step two elementary modes ($^+$) and ($^-$) are now considered for which $C = \pm c$ and there is the same function F. For these modes the corresponding field strengths are related by

$$\mathbf{B}^+ = -\mathbf{B}^- \qquad \mathbf{E}^+ = \mathbf{E}^- \tag{8}$$

according to Equations (6) and (7). Since the field equations are linear, the sum of the two solutions ($^+$) and ($^-$) also becomes a solution of the field equations, thereby resulting in the field strengths

$$\mathbf{B}_H = \mathbf{B}^+ + \mathbf{B}^- = 0 \tag{9}$$

$$\mathbf{E}_H = \mathbf{E}^+ + \mathbf{E}^- = \nabla \left\{ \left[1 + (\sin\theta)^2 D \right] 2F \right\}. \tag{10}$$

These strengths then stand for a "composite" mode having zero integrated charge q_o, zero magnetic moment M_0, and zero spin s_0, but a nonzero rest mass

$$m_0 = \frac{4\pi\varepsilon_0}{c^2} r_0 G_0^2 J_m = \left(\frac{1}{2}\varepsilon_0 E_{eq}^2\right)\left(\frac{4}{3}\pi r_0^3\right). \tag{11}$$

Here $E_{eq}^2 = 6(G_0/r_0)^2 J_m$, the dimensionless integral is

$$J_m = \int_0^\infty \int_0^\pi I_m \, d\rho \, d\theta \qquad I_m = fg \tag{12}$$

and

$$f(\rho,\theta) = -(\sin\theta) D \left[1 + (\sin\theta)^2 D\right] G \tag{13}$$

$$g(\rho,\theta) = -\left[1 + 2(\sin\theta)^2 D\right] G \tag{14}$$

when a convergent radial part R is now being chosen [3].

It has first to be observed that this composite mode can be related to an option of the Higgs boson which is not truly a fundamental particle but is built out of as yet unobserved constituents, as also stated by Quigg [1]. Moreover, the vanishing magnetic field $\mathbf{B}_H$ of Equation (9) is in a way related to the longitudinal "S-wave" of the earlier theory [3], as well as to the longitudinal state of a massive boson mentioned by Higgs [4]. Finally, the magnitude of the nonzero mass is so far not predicted by theory [1]. From Equation (11) it should be due to the energy density of an equivalent electric field E_{eq}. The absence of a magnetic field may also make the particle highly unstable.

3 Discussion

An experimental proof of an existing Higgs-like particle with zero net electric charge, zero spin, and nonzero rest mass could thus be taken as support of the present revised quantum electrodynamical theory [3]. The latter is characterized by intrinsic linear symmetry breaking, leading in general to nonzero rest masses of elementary particles.

Such a proof does on the other hand not for certain become a full experimental confirmation also for the same particle to provide all other elementary particles with mass through the completely different spontaneous nonlinear symmetry breaking interaction between the Higgs field and massless particle concepts of the Standard Model [1, 4].

Possible the present approach [3] and that of Higgs [1, 4] could have a point in common. This is trough the Zero Point Energy field being present all over space on one hand [3], and a generally existing Higgs field in space on the other [1, 4].

Submitted on April 28, 2013 / Accepted on April 29, 2013

References

1. Quigg C. The coming revolution in particle physics. *Scientific American*, February 2008, 38–45.
2. Garisto R. and Agarwal A. The import of the Higgs boson. *Scientific American*, September 2012, page 16.
3. Lehnert B. Revised quantum electrodynamics. Nova Science Publishers, New York 2013, Chapter 6.
4. Higgs P.W. Spontaneous symmetry breakdown without massless bosons. *Physical Review*, 1966, v. 145, 1156–1163.