Complete Relativity Predicts the Recently Reported Mass of the Higgs Boson

Ramzi Suleiman
University of Haifa

Please address all correspondence to:
Dr. Ramzi Suleiman, Department of Psychology, University of Haifa, Haifa, 31509, Israel, Email: suleiman@psy.haifa.ac.il, Mobile: + 972-(0)50-5474- 215, Homepage: http://suleiman.haifa.ac.il

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Abstract

In two recent articles I have shown that a relativity theory without the Lorentz Invariance Principle, termed Complete Relativity, conforms to quantum mechanics and cosmology. Here I demonstrate that it also conforms to the Standard Model. Using the energy expression derived from the theory, I demonstrate that the theory predicts the recently reported mass (≈125 GeV) of the Higgs boson.

Keywords: Higgs boson, Relativity, Lorentz Invariance Principle, ATLAS, CMS

Introduction

The possibility of existence of the recently discovered Higgs boson [1, 2] was proposed more than forty years ago. In the Standard Model (SM), electroweak symmetry breaking (EWSB) is achieved by invoking the Higgs mechanism, which requires the existence of the Higgs boson [3–6]. In the SM, the Higgs boson mass, m_H, is a priori unknown. However, for a given m_H hypothesis, the production cross sections and branching fractions of each decay mode are predicted, which enables a combined search with data from several decay channels [1]. In July 2012, the ATLAS [1] and CMS [2] collaborations announced that they had discovered a new particle with a mass ~125 GeV, which qualifies as a candidate for the theorized Higgs boson. ATLAS reported a particle mass $m_H \sim 126$ GeV with a local significance of 3.5 σ, and CMS reported a mass m_H = 125.3 ± 0.4(stat.) ± 0.5(syst.) GeV, with a local significance of 5 σ. In the signal region of (5.56 – 5.68) GeV, the reconstructed mass of Λ_b^0 and $\overline{\Lambda}{}_b^0$ using up to 4.6 fb^{-1} at 7 TeV of pp collision data is shown in Figure 1 (see [7] and [8]).

Here I show that the above quoted results are also in excellent agreement with the prediction of a new relativity theory without the Lorentz Invariance, termed Complete Relativity [9-14]. First I summarize the main features of the theory, and its resulting transformations. Following, I apply the theory's energy term to predict the reported Higgs boson mass.

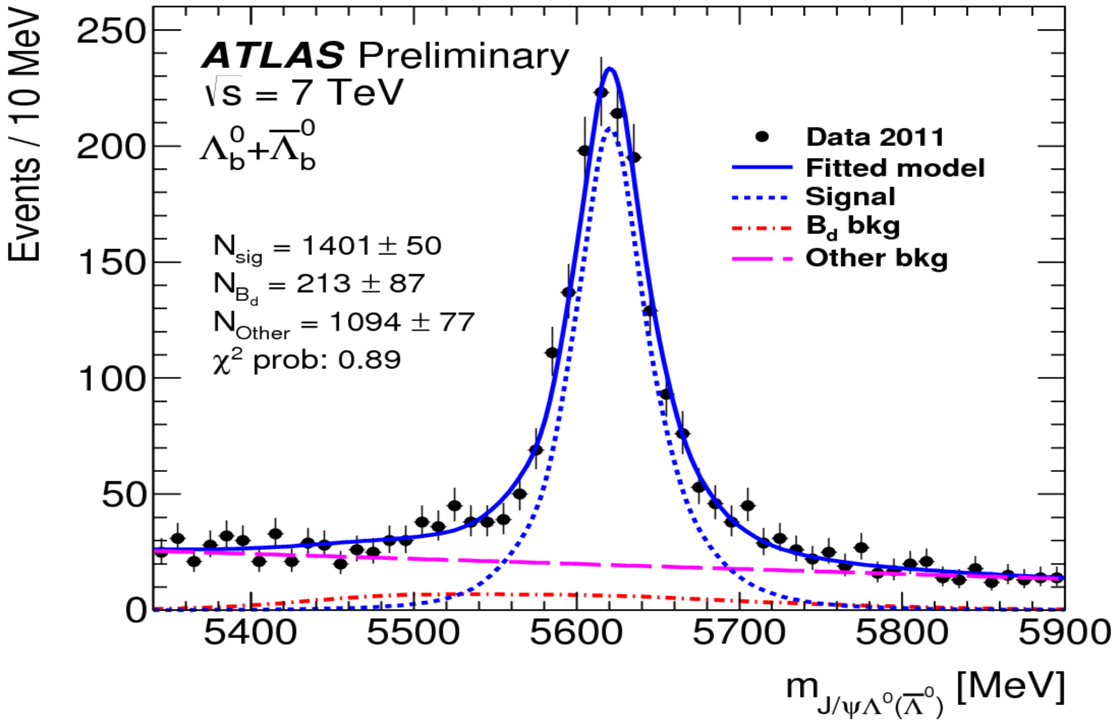

Figure 1. The reconstructed mass of Λ_b^0 and $\overline{\Lambda}_b^0$ candidates, fitted with a three-component PDF (blue solid curve) consisting of signal (blue dashed curve), combinatorial (magenta long-dashed straight line) and B_d^0 background (red dot-dashed curve, bottom). **(Source: [7])**

Complete Relativity

Recently, I have proposed a new theory of relativity for inertial systems, termed Complete Relativity [9-14]. The theory is based on the following propositions: 1.The laws of physics are the same in all inertial frames of reference. 2. The magnitudes of *all* physical entities, as measured by an observer, depend on the relative motion of the observer with respect to the rest frame of the measured entities. 3. The transformations of all physical entities, from one frame of reference to another, may depend on the methods used for their measurement. 4. All translations of information from one frame of reference to another are carried by light or electromagnetic waves of equal velocity. What is worth stressing here is that Complete Relativity abandons the Lorentz Invariance (and the corresponding constancy of the velocity of light).

A comprehensive presentation of Complete Relativity, including its time, distance, mass and energy transformations, is detailed in [9]. The resulting transformations are summarized in Table 1. The triplet (t, x, ρ) in the table denotes the time, distance, and mass-density as measured in an observer's internal frame, while the triplet (t', x', ρ') denotes the corresponding variables, as measured at the internal frame of an object with mass-density ρ', which moves with constant velocity $\beta = \frac{v}{c}$ relative to the observer's frame.

Table 1

Complete Relativity Transformations

Time (One-Way) $\frac{\boldsymbol{t}}{\boldsymbol{t'}}$	**Time** (Round Trip) $\frac{\boldsymbol{t}}{\boldsymbol{t'}}$	**Distance** $\frac{\boldsymbol{x}}{\boldsymbol{x'}}$	**Mass-Density** $\frac{\boldsymbol{\rho}}{\boldsymbol{\rho'}}$	**Kinetic Energy** $\frac{E}{m_0\, c^2}$
$\frac{1}{1-\beta}$	$\frac{2}{1-\beta^2}$	$\frac{1+\beta}{1-\beta}$	$\frac{1-\beta}{1+\beta}$	$\frac{1}{2}\,\beta^2 \frac{1-\beta}{1+\beta}$

Note that for β →0 (v << c), all the expressions in the table reduce to the corresponding Newtonian expression.

In this short note, I focus on the Kinetic Energy expression. As shown by the table, the kinetic energy for a body of mass m_0 is given by:

$$E = \frac{1}{2}\, m_0\, c^2\, \frac{(1-\beta)}{(1+\beta)}\, \beta^2 = \frac{1}{2}\, m_0\, c^2\, \frac{(1-\beta)}{(1+\beta)}\, \beta^2 \qquad \text{….. (1)}$$

where $\beta = \frac{v}{c}$

Figure 2 depicts $\frac{E}{m_0\, c^2}$ as a function of the velocity β. Quite strikingly, for departing bodies (positive β values), the kinetic energy displays a non-monotonic behavior. It increases with β up to a maximum at velocity $\beta = \beta_{cr}$, and then decreases to zero at β = 1. To calculate β_{cr} I derive $\frac{E}{m_0\, c^2}$ with respect to β and equate the result to zero:

$$\frac{\boldsymbol{d}}{\boldsymbol{d\beta}}\left(\beta^2 \frac{(\mathbf{1}-\boldsymbol{\beta})}{(\mathbf{1}+\boldsymbol{\beta})}\right) = 2\,\beta\, \frac{(\mathbf{1}-\boldsymbol{\beta})}{(\mathbf{1}+\boldsymbol{\beta})} + \beta^2 \frac{[(\mathbf{1}+\boldsymbol{\beta})(-\mathbf{1})-(\mathbf{1}-\boldsymbol{\beta})(\mathbf{1})]}{(\mathbf{1}+\boldsymbol{\beta})^{\mathbf{2}}} = 2\,\beta \frac{(\mathbf{1}-\boldsymbol{\beta}^{\mathbf{2}}-\boldsymbol{\beta})}{(\mathbf{1}+\boldsymbol{\beta})^{\mathbf{2}}} = 0. \qquad \text{.... (2)}$$

for $\beta \neq 0$ and we get:

$$\beta^2 + \beta - 1 = 0 \qquad \text{....(3)}$$

Which solve for positive β at:

$$\boldsymbol{\beta_{cr}} = \frac{\sqrt{5}-1}{2} = \Phi \approx 0.618 \qquad \text{....(4)}$$

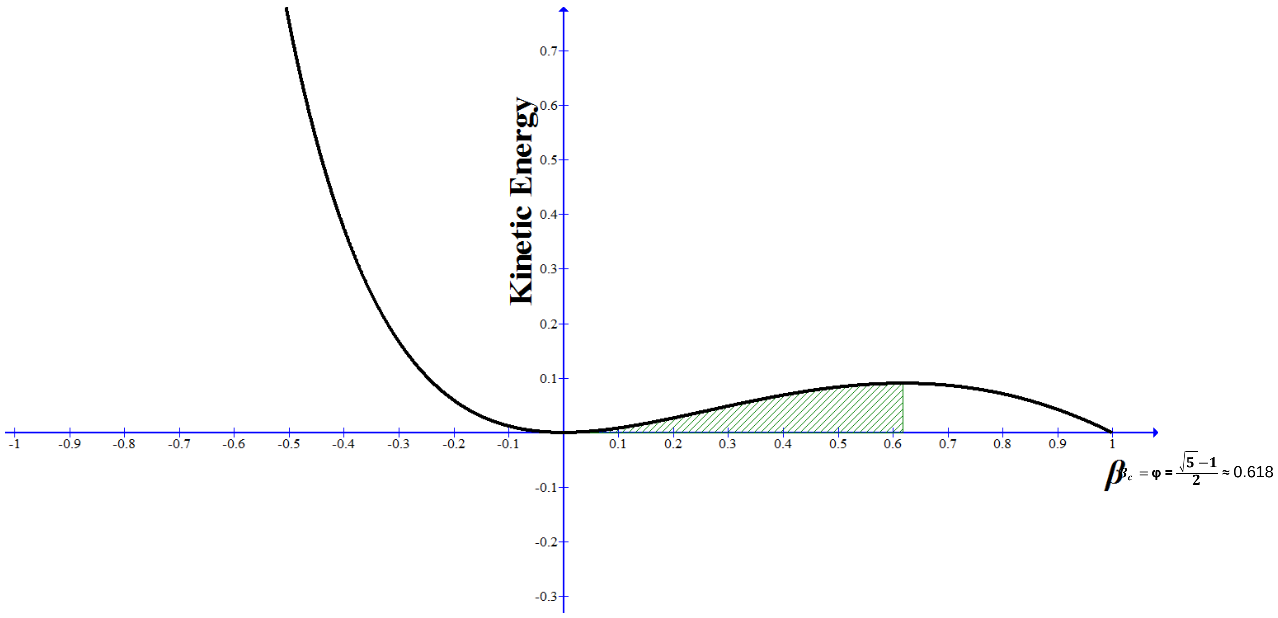

Figure 2. Kinetic energy as a function of velocity

Where Φ is the Golden Ratio [15, 16]. Substituting $\boldsymbol{\beta_{cr}}$ in the energy expression (Eq. 1) yields :

$$E_{max} = \tfrac{1}{2}\, m_0\, c^2 \quad \Phi^2 \frac{1-\Phi}{1+\Phi} \qquad \text{.... (5)}$$

From Eq. 3 we can write: $\Phi^2 + \Phi - 1 = 0$, which implies $1 - \Phi = \Phi^2$ and $1 + \Phi = \frac{1}{\Phi}$.

Substitution in Eq. 5 gives:

$$E_{max} = \tfrac{1}{2}\, \Phi^5\, m_0\, c^2 \;\approx \frac{0.09016994}{2}\, E_0 \approx 0.04508497\, m_0\, c^2 \qquad \text{.... (6)}$$

In the framework of Complete Relativity, $\beta_{cr} = \Phi \approx 0.618$ is the velocity at which the increase in Kinetic energy is balanced by the relativistic decrease in mass [5]. In a cosmological perspective, this is the energy point at which baryonic matter was constructed. For velocities higher than β_{cr}, the universe is dominated by dark matter and dark energy, while for velocities lower than β_{cr}, the amount of baryonic matter enforce semi-Newtonian kinematics according to which the kinetic energy of a mass m_0 is positively proportional to its velocity. More on the application of Complete Relativity to cosmology, including the definitions of dark matter and dark energy, and the prediction of their amounts in the universe, is detailed in [5].

Prediction of the Higgs boson mass

For a particle with kinetic energy e, using Eq. 6 we can write:

$$m_0\, c^2 = 2\, \Phi^{-5}\, e \qquad \text{…. (7)}$$

For the lower bound of the signal region of (5.56 – 5.68) GeV, reported by ATLAS, we have:

$$m_0\, c^2 = 2 \text{ x } \left(\frac{\sqrt[2]{5}-1}{2}\right)^{-5} \text{ x } 5.56 \text{ (GeV)} \approx 22.180 \text{ x } 5.56 \text{ (GeV)} \approx 123.321 \text{ GeV.} \qquad \text{….(8)}$$

And for the upper bound we have

$$m_0\, c^2 = 2 \text{ x } \left(\frac{\sqrt[2]{5}-1}{2}\right)^{-5} \text{ x } 5.68 \text{ (GeV)} \approx 22.180 \text{ x } 5.68 \text{ (GeV)} \approx 125.983 \text{ GeV.} \qquad \text{….(9)}$$

And the average mass is equal to

$$m_0\, c^2 \approx \frac{123.321+125.982}{2} \approx 124.652 \text{ GeV.} \qquad \text{…. (10)}$$

Which highly agrees with the reported results of the mass of the Higgs boson.

Conclusions

The present article demonstrates that a relativity theory without the Lorentz Invariance Principle yields a very good prediction of the recently reported mass of the Higgs boson. It is commonly known that the existence of the Higgs boson has for long been predicted by Higgs and others (e.g., [3-6]). This does not create a conflict between the two theories. On the contrary, the agreement between two theories, each coming from a completely different approach, coupled with the point prediction, reported above, of the Higgs mass should add validity to both approaches.

The prediction of the Higgs mass by Complete Relativity Theory adds to previously reported results attesting to the success of the theory in predicting the content of the universe (see 9), the Planck constant (see 14), the results of neutrino velocity experiments conducted by OPERA and four other collaborations [17-22] (see 10, 12), quantum criticality at the Golden Ratio, reported in [23] (see 9, and 14), the time dilation observed for the decay of μ-mesons [24], the Michelson and Morley's "null" results [25] (see 11), and more. No less important, at high enough energies the theory conforms, at several meeting points, with Quantum Mechanics, the Standard Model of elementary particles physics, and cosmology; while at low enough velocities it conforms with Newtonian mechanics.

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