Numerical Formulas for the Higgs Boson Mass

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Abstract

This paper is concerned with the numeric formulas for the Higgs boson mass. The formulas presented here are in agreement with the with the ATLAS detector's results obtained in 2014 through the $H \rightarrow \gamma\gamma$ and $H \rightarrow ZZ^* \rightarrow 4l$ *decay channels.*

Keywords: *Higgs boson, electromagnetic coupling constant.*

1. The Numeric Formulas for the Higgs Boson Mass

This section introduces three different numeric formulas for the Higgs boson mass.

1.1 Formula 1

Let us assume that there is a relationship between the *Higgs scale*, the *proton scale* and the *electron scale* and that this relationship is given by

$$\frac{M_{H1}}{m_p} = S \left(\frac{m_p}{m_e} \right) \tag{1}$$

Where

M_{H1} = Higgs boson mass
m_p = proton rest mass
m_e = electron rest mass
S = scale factor

Equation (1) means that the ratio between the *Higgs mass* to the *proton mass* is proportional to the ratio between the *proton mass* to the *electron mass*. Now, let us postulate that the scale factor is 10 times the electromagnetic coupling constant α. Thus the equation for the Higgs mass is

$$M_{H1} = 10\alpha \left(\frac{m_p^2}{m_e} \right) \tag{2}$$

or

$$M_{H1} = \frac{10\alpha \; m_p^2}{m_e} \tag{3}$$

Where

α = fine structure constant or electromagnetic coupling constant.
$S = 10\alpha$ = scale factor

The value calculated with this numeric formula is

$$M_{H1} = 224.115\,485\,4 \times 10^{-27}\ Kg$$

$$M_{H1} = 125.890\,595\,7\ GeV/c^2$$

1.2 Formula 2

The second numeric formula for the Higgs boson mass is

$$M_{H2} = \frac{\sqrt{5}}{3}\alpha^2\left(\frac{m_p^3}{m_e^2}\right) \tag{4}$$

The value calculated with this formula is

$$M_{H2} = 223.825\,586\,6 \times 10^{-27}\ Kg$$

$$M_{H2} = 125.728\ GeV/c^2$$

1.3 Formula 3

The third numeric formula for the Higgs boson mass is

$$M_{H3} = \frac{1}{18}\alpha^3\left(\frac{m_p^4}{m_e^3}\right) \tag{5}$$

The value calculated with this formula is

$$M_{H3} = 223.536\,062\,9 \times 10^{-27}\ Kg$$

$$M_{H3} = 125.565\ GeV/c^2$$

2. Comparison

The experimental value of the Higgs mass, according to the results from the ATLAS experiment [1], is

$$M_{H-\exp}(ATLAS\ 2014) = [125.36 \pm 0.37\,(\text{stat}) \pm 0.18\,(\text{syst})]\ GeV/c^2$$

Considering both the statistical and systematic errors the minimum and the maximum experimental values turn out to be

$$M_{H-\exp-\min}(ATLAS\ 2014) = 124.81\ GeV/c^2 \quad \text{and}$$

$$M_{H-\exp-\max}(ATLAS\ 2014) = 125.91\ GeV/c^2$$

respectively.

The arithmetic mean for the above values is

$$M_{H-\exp-mean}(ATLAS\ 2014) = 125.36\ GeV/c^2$$

or in kilograms

$$M_{H-\exp-mean}(ATLAS\ 2014) = 223.170\ 897\ 7 \times 10^{-27}\ Kg$$

Table 1 shows the comparison of the values obtained with the three numerical formulas given above with the ATLAS results published by the CERN in June 2014

Experimental and Theoretical Values	Description
$M_{H-\exp-\max}(ATLAS\ 2014) = 125.91\ GeV/c^2$	*Maximum experimental value from ATLAS*
$M_{H1} = 125.891\ GeV/c^2$	*Numeric value 1 - formula (3) (2012)*
$M_{H2} = 125.728\ GeV/c^2$	*Numeric value 2 – formula (4) (2014)*
$M_{H3} = 125.565\ GeV/c^2$	*Numeric value 3 - formula (5) (2014)*
$M_{H-\exp-mean}(ATLAS\ 2014) = 125.36\ GeV/c^2$	*Experimental arithmetic mean from ATLAS*
$M_{H-\exp-\min}(ATLAS\ 2014) = 124.81\ GeV/c^2$	*Minimum experimental value from ATLAS*

Table 1*: This table shows that the numerical values of the Higgs mass fall into the experimental error range from the ATLAS experiment.*

We observed that all the numeric results presented in this paper are higher than the experimental arithmetic mean ($125.36\, GeV / c^2$). References [2, 3, 4, 5, 6] provide additional material on the Higgs boson mass.

3. Conclusions

Thus we conclude that the numerical formulas for the Higgs boson mass introduced in this paper are in excellent agreement with the experiment. However, this does not mean that any of the above formulas is the exact nature's description for the Higgs boson mass; they are just a numerical formulas.

4. Notes

The first formula (equation 2) of this investigation was published for the first time in May 2014 as part of another paper [7]. The reason to publish it as a separate article is twofold: a) for clarity reasons and b) to add two more formulas.

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