# Determination of the Higgs Boson's Mass

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## Abstract

In our previous papers, we gave formulas of the fine-structure constant and their corresponding applications along with a mass model of the elementary particles. And in a recent paper, we redefined Hartree atomic units to Hartree-Chen atomic units. In this paper, we apply our mass model of the elementary particles and Hartree-Chen atomic units to determine the exact value of the Higgs boson's mass. Based on our hypothetical formulas, the Higgs boson's in Hartree-Chen atomic units should be 245280.001934, and the exact value of the Higgs boson's mass should be 125.33782309(4) GeV. Compared to the value of 125.35 ± 0.15 GeV which was measured out by CERN in 2016, our calculated value is almost absolutely precise if it is correct. By the new value of 125.11(11) GeV reported by ATLAS Collaboration, we revised the calculated value for the Higgs boson's mass to 125.15375720(4) GeV.

**Keywords:** mass, the Higgs Boson, atomic units.

## 1. Introduction

Reporting the observation of the Higgs boson at the CERN LHC on July 4, 2012, was undoubtedly one of the greatest achievements of experimental physics in the beginning of the 21th century. Since then, scientists the ATLAS and CMS Collaborations have been busy understanding exactly its place within the standard model of particle physics. One important goal was to determine the mass of the Higgs Boson precisely. To achieve this goal, CMS physicists combined data from two very different, very accurate measurements. One measurement looked at decays to two Z bosons, which subsequently decay into electron or muon pairs, and the other focused on decays to two photons. With the enormous amount of work spent over many years to carefully calibrate and model the CMS detector, they measured the Higgs boson mass with high precision. Using data obtained in 2011 and 2012 the mass was measured as 125.06 ± 0.29 GeV. Using the 2016 data, this measurement improved to 125.46 ± 0.17 and with everything combined gives the best mass determination yet of 125.35 ± 0.15 GeV, just with an uncertainty of roughly 0.1%! [1]

In our previous papers, we gave formulas of the fine-structure constant and their corresponding applications [2, 3, 5-14] along with a mass model of the elementary particles [4]. And in a recent paper [15], we redefined Hartree atomic units to Hartree-Chen atomic units. In this paper, we apply our mass model of the elementary particles and Hartree-Chen atomic units to determine the exact value of the Higgs boson's mass.

## 2. Determination of the Higgs Boson's Mass

We use the general formula of our mass model of the elementary particles [4] to determine the mass of the Higgs boson in Hartree-Chen atomic units. It is also supposed that the value and the factors in the formula of the Higgs boson's mass in Hartree-Chen atomic units are meaningful and related to nuclides.

Hartree-Chen Atomic Units (au):

$$\hbar_{au} = e_{au} = a_{0/au} = 1$$

$$m_{e/au} = 1 + \frac{1}{{c_{au}}^4}, \quad m_{e^+/au} = 1 - \frac{1}{{c_{au}}^4}$$

$$\hbar_{au} = \frac{h_{au}}{(2\pi)_{au}} = 1, \quad h_{au} = (2\pi)_{au} = \frac{4\times 157}{100} = 6.28$$

$$c_{au} = \frac{c}{v_e} = \sqrt{112(168 - \frac{1}{3} + \frac{1}{12\cdot 47} - \frac{1}{14\cdot 112\cdot(2\cdot 173+1)})} = 137.035999074626$$

$c$: the speed of light in vacuum

$v_e$: the line speed of the ground state electron of H atom in Bohr model

Electron mass： $m_e = 0.51099895000(15)\ MeV$

CERN measured the Higgs boson's mass (2016)： $m_H = 125.35(15)\ GeV$

The mass ratio of the Higgs boson to electron:

$$\beta_{H/e} = \frac{m_H}{m_e} = \frac{125.35(15)\times 10^3}{0.51099895000(15)} = 2.4530(29)\times 10^5 \ (245010 - 245597)$$

$$m_{H/au} = \frac{m_H}{m_e/(1+1/{c_{au}}^4)} = ?$$

Based on our mass model of the elementary particles, we constructed the following formulas for the Higgs boson's mass in Hartree-Chen atomic units (au):

$$m_{H/au} = \frac{m_H}{m_e/(1+1/c_{au}{}^4)} = 32\cdot3\cdot5\cdot7\cdot73 + \frac{1}{11\cdot47} = [22(22+1-\frac{1}{2}+\frac{1}{5\cdot17+\frac{13}{30}})]^2$$

$= 245280.001934$

It is supposed that the integer part of the value of $m_{H/au}$ having small prime factors as many as possible is special and more meaningful in their relationships with nuclides.

$^{20,21,22}_{10}Ne_{10,11,12}$ $^{23}_{11}Na_{12}$ $^{24,25,26}_{12}Mg_{12,13,14}$ $^{27}_{13}Al_{14}$ $^{28,29,30}_{14}Si_{14,15,16}$ $^{31}_{15}P_{16}$ $^{32,33,34}_{16}S_{16,17,18}$ $^{35,37}_{17}Cl_{18,20}$

$^{47,48,50}_{22}Ti_{25,26,28}$ $^{50,52,54}_{24}Cr_{26,28,30}$ $^{54,56,58}_{26}Fe_{28,30,32}$ $^{58,60,62}_{28}Ni_{30,32,34}$ $^{63,65}_{29}Cu_{34,36}$ $^{64,66,68}_{30}Zn_{34,36,38}$

$^{70,72,73,74,76}_{32}Ge_{38,40,41,42,44}$ $^{79,81}_{35}Br_{44,46}$ $^{83.84,86}_{36}Kr_{47,48,50}$ $^{85,87}_{37}Rb_{48,50}$ $^{90,92,94,96}_{40}Zr_{50,52,54,56}$ $^{100}_{44}Ru_{56}$

$^{107,109}_{47}Ag_{60,62}$ $^{112}_{48}Cd_{64}$ $^{114,118,119,120}_{50}Sn_{64,68,69,70}$ $^{125,126}_{52}Te_{73,74}$ $^{136,137,138}_{56}Ba_{80,81,82}$ $^{140,142}_{58}Ce_{82,84}$

$^{3\cdot47}_{59}Pr_{82}$ $^{143,144,145,146}_{60}Nd_{83,84,85,86}$ $^{145,146}_{61}Pm^*_{84,85}$ $^{154,156,157,158,160}_{64}Gd_{90,92,93,2\cdot47,96}$ $^{168}_{68}Er_{100}$ $^{169}_{69}Tm_{100}$

$^{173}_{70}Yb_{103}$ $^{180,181}_{73}Ta_{107,108}$ $^{4\cdot47}_{76}Os_{112}$ $^{200}_{80}Hg_{120}$ $^{209}_{83}Bi^*_{126}$ $^{209}_{84}Po^*_{125}$ $^{210}_{85}At^*_{125}$ $^{223}_{87}Fr^*_{136}$ $^{235,14\cdot17}_{92}U^*_{143,146}$

$^{257}_{100}Fm^*_{157}$ $^{285}_{112}Cn^*_{173}$ $^{2\cdot157}_{126}Ch^{ie}_{4\cdot47}$ $^{344,2\cdot173,348}_{137}Fy^{ie}_{208,209,210}$ $^{6\cdot59}_{141}Ch^{ie}_{213}$ $^{370}_{146}Ch^{ie}_{224}$ $^{400}_{157}Ch^{ie}_{243}$ $^{435}_{173}Ch^{ie}_{262}$

Among the above nuclides, the following are more important and meaningful:

$^{47,48,50}_{22}Ti_{25,26,28}$ $^{83.84,86}_{36}Kr_{47,48,50}$ $^{107,109}_{47}Ag_{60,62}$ $^{85,87}_{37}Rb_{48,50}$ $^{145,146}_{61}Pm^*_{84,85}$ $^{4\cdot47}_{76}Os_{112}$ $^{209}_{83}Bi^*_{126}$

$^{210}_{85}At^*_{125}$ $^{235,14\cdot17}_{92}U^*_{143,146}$ $^{2\cdot157}_{126}Ch^{ie}_{4\cdot47}$ $^{370}_{146}Ch^{ie}_{224}$

So the exact value of Higgs boson's mass should be:

$$m_H = m_{H/au}\frac{m_e}{1+1/c_{au}{}^4} = 245280.001934\times\frac{0.51099895000(15)}{1+1/137.037999074626^4}$$

$=125.33782309(4)\ GeV$

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### 3. The Frequency of the Photon Corresponding to the Higgs Boson's Mass

If a Higgs boson became a photon, what would be its frequency in Hartree-Chen atomic units (au)?

$$h_{au}\nu_{H/au} = m_{H/au}c_{au}{}^2$$

$$\nu_{H/au} = \frac{m_{H/au}c_{au}{}^2}{h_{au}} = \frac{(32\cdot3\cdot5\cdot7\cdot73+\frac{1}{11\cdot47})\times137.035999074626^2}{6.28} = 733452237.885023$$

$$\nu_{H/au} = 2(16\cdot3\cdot5\cdot7\cdot17-1)(8\cdot3\cdot5\cdot107+1)-\frac{1}{8}+\frac{1}{99+47/61} = 733452237.885023$$

$^{32,33,34,36}_{16}S_{16,17,18,20}$ $^{35,37}_{17}Cl_{18,20}$ $^{56}_{26}Fe_{30}$ $^{58,60,61,62,64}_{28}Ni_{30,32,33,34,36}$ $^{64,68,70}_{30}Zn_{34,38,40}$ $^{75}_{33}As_{42}$ $^{85,87}_{37}Rb_{48,50}$

$^{74,76,80,82}_{34}Se_{40,42,46,48}$ $^{99,100}_{44}Ru_{55,56}$ $^{107,109}_{47}Ag_{60,62}$ $^{112}_{48}Cd_{64}$ $^{118,119}_{50}Sn_{68,69}$ $^{136,137}_{56}Ba_{80,81}$ $^{145,146}_{61}Pm^*_{84,85}$

$^{167,168}_{68}Er_{99,100}$ $^{180,181}_{73}Ta_{107,108}$ $^{4\cdot47}_{76}Os_{112}$ $^{200}_{80}Hg_{120}$ $^{210}_{85}At^*_{125}$ $^{223,224}_{87}Fr^*_{136,137}$ $^{2\cdot137}_{107}Bh^*_{167}$ $^{276}_{108}Hs^*_{168}$ $^{285}_{112}Cn^*_{173}$

$2023/1/20-21$

## 4. New Determination of the Higgs Boson's Mass

ATLAS Collaboration of CERN LHC reported the most recent measurement results for the mass of Higgs boson. The latest and most accurate measurement value is 125.11(11) MeV [16].. By this new value, we modify our previous formulas and calculations for the mass of Higgs boson, the new ones are as follows

$$m_{H/au}=\frac{m_H}{m_e/(1+1/c_{au}{}^4)}=8\cdot 3\cdot 5\cdot 13\cdot 157-\frac{1}{4}+\frac{1}{22}-\frac{1}{4\cdot 7\cdot 23}$$

$$=[22(22+\frac{1}{2}-\frac{1}{9\cdot 23})]^2=244919.79390$$

It is supposed that the integer part of the value of $m_{H/au}$ having small prime factors as many as possible and having a large unique prime factor such as 157 is special and more meaningful in their relationships with nuclides.

${}^{50}_{22}Ti_{28}$ ${}^{50,51}_{23}V_{27,28}$ ${}^{52}_{24}Cr_{28}$ ${}^{56}_{26}Fe_{30}$ ${}^{89}_{39}Y_{50}$ ${}^{92}_{40}Zr_{52}$ ${}^{100}_{144}Ru_{56}$ ${}^{104}_{46}Pd_{58}$ ${}^{119}_{50}Sn_{69}$ ${}^{119}_{50}Sn_{69}$

${}^{125,126}_{52}Te_{73,74}$ ${}^{136}_{56}Ba_{80}$ ${}^{156,157}_{64}Gd_{92,93}$ ${}^{169}_{69}Tm_{100}$ ${}^{200}_{80}Hg_{120}$ ${}^{207,208}_{82}Pb_{125,126}$ ${}^{235,238}_{92}U^{*}_{143,146}$

${}^{257}_{100}Tm^{*}_{157}$ ${}^{2\cdot 157}_{126}Ch^{ie}_{188}$ ${}^{344}_{136}Fy^{ie}_{208}$ ${}^{400}_{157}Ch^{ie}_{243}$

So the exact value of Higgs boson's mass should be:

$$m_H=m_{H/au}\frac{m_e}{1+1/c_{au}{}^4}=244919.79390\times\frac{0.51099895000(15)}{1+1/137.037999074626^4}$$

$$=125.15375716(4)\text{ GeV}$$

2023.12.29

If a Higgs boson became a photon, its frequency in Hartree-Chen atomic units (au) would be as follows.

$$h_{au}\nu_{H/au}=m_{H/au}c_{au}{}^2$$

$$\nu_{H/au}=\frac{m_{H/au}c_{au}{}^2}{h_{au}}=\frac{(244920-\frac{1}{4}+\frac{1}{22}-\frac{1}{4\cdot 7\cdot 23})\times 137.035999074626^2}{6.28}=732375120.372$$

$$\nu_{H/au}=16\cdot 3\cdot 5[4\cdot 3\cdot 109(4\cdot 11\cdot 53+1)-1]+\frac{3}{8}=732375120.375$$

$$8\nu_H=5859000963=9(2\cdot 173+1)[2\cdot 13\cdot 59\cdot(2\cdot 13\cdot 47+1)-1]$$

The prime factors in above formulas seems not relevant to nuclides.

2023/12/29

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## Appendix I: Research and Writing History

| Section | Pages | Writing Period | Location | Version |
|---|---|---|---|---|
| Whole paper | 3 | 2022/8/9-10 | Chengdu | viXra:2208.0048v1 |
| Whole paper | 4 | 2022/12.21-22 | Shanghai | viXra:2208.0048v2 |
| Add Section 3 | 4 | 2023/1/20-21 | Shanghai | viXra:2208.0048v3 |
| Add Section 4 | 5 | 2023/12/29-30 | Chengdu | viXra:2208.0048v4 |

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