

The “Alpha-12” Mass Formula

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March 2015 (v1)

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Abstract

The formula presented in this paper predicts the masses of 17 baryons, one lepton and 6 other particles. The formula uses non-consecutive quantum numbers. The maximum accuracy of the formula is 3 decimal places and the minimum is 2. This paper predicts a new particle with a rest mass between $4557.2 \text{ MeV}/c^2$ and $4658.2 \text{ MeV}/c^2$. The formula suggests the existence of a more general formula for the masses of all known particles, which is yet, to be discovered.

Keywords: quark, baryon, pentabaryon, lepton, quantum number, “allowed” quark number, Newton's gravitational constant, tau particle, Planck's constant, permittivity of vacuum, fine-structure constant, NIST.

1. Introduction

In a previous article [1] I published the formula for the mass of the proton

$$m_p = \frac{m_e}{A(1-A)} \quad (1.1)$$

In that paper I showed that if we adopt the value of $6.671\ 614\ 932 \times 10^{-11} \text{ m}^3 \text{ Kg}^{-1} \text{ S}^{-2}$ for Newton's gravitational constant, G , the formula yields the exact mass of the proton accurate to 9 decimal places. In this article I shall generalize this formula so that the modified formula, which I shall call *the Alpha-12 formula*, yields the masses of a number of particles (including all baryons, one lepton and other relatively heavy unknown particles). The price we have to pay for this generalization is a reduction in accuracy. In other words the generalized formula that I shall introduce in the next section is not as accurate as formula (1.1).

2. The Alpha-12 Mass Formula

The modification consists in raising the parenthesis, $(1 - A)$, of equation (1.1) to the power of n , where n represents non-consecutive or “allowed” quantum numbers. While formula (1.1) is exact, provided we use the theoretical value of the gravitational constant proposed in the above-mentioned article, the Alpha-12 generalized formula is numeric. The Alpha-12 mass formula in terms of m_e and A is

$$m \approx \frac{m_e}{A(1-A)^n} \quad (2.1)$$

where

$$A = \alpha^{12} \left(\frac{M_P}{m_e} \right) \quad (2.2)$$

$$M_P = \sqrt{\frac{hc}{2\pi G}} \quad (2.3)$$

$$\alpha = \frac{e^2}{2\epsilon_0 hc} \quad (2.4)$$

The final “Alpha-12” mass formula in terms of m_e , α and M_P is

$$m \approx \frac{m_e}{\alpha^{12} \left(\frac{M_P}{m_e} \right) \left[1 - \alpha^{12} \left(\frac{M_P}{m_e} \right) \right]^n} \quad (2.5)$$

where

m = predicted rest mass of a particle

m_e = electron rest mass

M_P = Planck mass

α = fine-structure constant

e = elementary charge

ϵ_0 = permittivity of vacuum

h = Planck's constant

c = speed of light in vacuum

G = Newton's gravitational constant (**Note 1**)

n = non consecutive or “allowed” quantum numbers (exponent)

$F_{J_{eV}} = 1.602176564 \times 10^{-19} \frac{J}{eV}$ = conversion factor

Note 1: *The value of the gravitational constant used in this paper is the value published by NIST 2010: $G_{NIST} = 6.67384 \times 10^{-11} m^3 Kg^{-1} S^{-2}$*

Note 2: *There are other baryons, also known as “exotic” baryons, which are made up of four quarks and one anti-quark (pentaquarks). We shall not consider pentaquarks in this paper.*

3. Results

The values equation (2.5) yields are shown on table 1. The table shows that this formula is a good approximation for the masses of baryons, the tau particle and other six unknown particles: Y(3940), Y(4140), Y(4260), Z(4430), Zb1(10610) and Zb2(10650). It is worthy to remark that the quantum number n is a non-consecutive quantum number.

Particle name	Symbol	Quark content, lepton or other	Observed rest mass (MeV/c ²)	Observed rest mass (Kg)	“Allowed” quantum numbers (n)	Predicted mass m (Kg) (Equation 2.5)
proton	p	uud	938.272	1.6726217771E-27	1	1.6729005220E-27
neutron	n	udd	939.5653	1.674927292E-27	3	1.6747248825E-27
Lambda 0	Λ^0	uds	1115.683	1.988885514E-27	318	1.9883694870E-27
Sigma +	Σ^+	uus	1189.37	2.120244517E-27	436	2.1204357199E-27
Sigma 0	Σ^0	uds	1192.642	2.126077387E-27	441	2.1262214850E-27
Sigma -	Σ^-	dds	1197.449	2.134646642E-27	448	2.1343480878E-27
Delta ++	Δ^{++}	uuu	1232	2.196239391E-27	501	2.1968944476E-27
Delta +	Δ^+	uud	1232	2.196239391E-27	501	2.1968944476E-27
Delta 0	Δ^0	udd	1232	2.196239391E-27	501	2.1968944476E-27
Delta -	Δ^-	ddd	1232	2.196239391E-27	501	2.1968944476E-27
Xi 0	Ξ^0	uss	1314.86	2.343950752E-27	619	2.3428107754E-27
Xi -	Ξ^-	dss	1321.71	2.356161985E-27	630	2.3568973737E-27
Omega -	Ω^-	sss	1672	2.980610603E-27	1061	2.9809106232E-27
Tau [2]	τ	lepton	1776.821	3.167471000E-27	1172	3.1667970325E-27
Y1	Y(3940)	?	3940	7.023687664E-27	2633	7.0211298528E-27
Y2	Y(4140)	?	4140	7.380220033E-27	2725	7.3821250031E-27
Y3	Y(4260)	?	4260	7.594139454E-27	2777	7.59431590343E-27
Z1	Z(4430)	?	4430	7.897191968E-27	2849	7.8982247074E-27
Xi0b [3]	Ξ_b^0	usb	5791.80	1.032480871E-26	3340	1.0321396374E-26
Xi'-b [4] (state with spin 1/2)	$\Xi_b'^-$	dsb	5935.02	1.058013370E-26	3386	1.058341074E-26
Xi*-b [5] (state with spin 3/2)	Ξ_b^{*-}	dsb	5955.33	1.061633956E-26	3391	1.0612288360E-26
Omega b - [4]	Ω_b^-	ssb	6165	1.099011027E-26	3456	1.099494644E-26
Zb1	Zb1(10610)	?	10610	1.891404216E-26	4451	1.890989841136E-26
Zb2	Zb2(10650)	?	10650	1.898534864E-26	4458	1.898211618911E-26

Table 1: The last column of the table shows the predicted mass for seventeen baryons, one lepton (the tau particle) and six unknown particles. The digits (including the decimal places) shown in either blue or white

indicate that these digits coincide with the corresponding digits of the observed values. It is worthy to observe that the Ξ_b^0 baryon is about 6.17 times as massive as the proton. Note that the literature could use different names for some of the particles shown here.

3. How to Predict New Particles from the Alpha-12 Mass Formula

The formula presented in this paper allow us to predict new particles. I shall illustrate this point by predicting the mass range for a new particle that I shall call: X . Let us have a look at table 1. Firstly, let us compute the differences between the “allowed” quantum numbers corresponding to the pair of particles Y_2 and Y_1 , between the pair Y_3 and Y_2 and between the pair Z_1 and Y_3 . These differences are shown on table 2.

Pair number	Pair of particles	“Allowed” quantum numbers for the pair of particles of column 1	“Allowed” quantum number difference
1	Y_2 and Y_1	2725 - 2633	92
2	Y_3 and Y_2	2777 - 2725	52
3	Z_1 and Y_3	2849 - 2777	72

Table 2: The table shows the “allowed” quantum number difference between three Y_2 and Y_1 , between Y_3 and Y_2 ; and between Z_1 and Y_3 . Note that the literature could use different names for the particles shown here.

Secondly, let us have a look at table 2. This table shows that the minimum difference (52) between quantum numbers corresponds to pair 2. The maximum difference (92) between quantum numbers corresponds to pair 1. The mean of the differences is 72. Thirdly, based on these three differences we can postulate that it is very likely that a new particle exists between the “allowed” quantum numbers $2849 + 52 = 2901$ and $2849 + 92 = 2941$. Now if we use these two quantum numbers in equation (2.5) we get

$$m_X(\min) = 8.125 \times 10^{-27} \text{ Kg} \quad \text{for } n = 2901$$

$$m_X(\max) = 8.304 \times 10^{-27} \text{ Kg} \quad \text{for } n = 2941$$

the value we get with the mean quantum number of: $(2901 + 2941)/2 = 2921$ is

$$m_X(\text{mean}) = 8.214 \times 10^{-27} \text{ Kg}$$

Prediction

Formula (2,5) seems to predict the existence of a new particle with a rest mass in the following mass range:

$$m_x(\min) = 8.124 \times 10^{-27} \text{ Kg} = 4557.2 \text{ MeV}/c^2$$

and

$$m_x(\max) = 8.304 \times 10^{-27} \text{ Kg} = 4658.2 \text{ MeV}/c^2 .$$

or equivalently

$$4557.2 \frac{\text{MeV}}{c^2} \leq m_x \leq 4658.2 \frac{\text{MeV}}{c^2}$$

This prediction is yet to be confirmed by the experiment.

4. Conclusions

The equation introduced in this paper predicts the masses of 17 baryons, one lepton (the tau particle), and six additional heavy particles: Y(3940), Y(4140), Y(4260), Z(4430), Zb1(10610) and Zb2(10650). The minimum accuracy of the formula is 2 decimal places and the maximum is 3. Additionally, this paper predicts the existence a new particle with a mass in the following range:

$$4557.2 \frac{\text{MeV}}{c^2} \leq m_x \leq 4658.2 \frac{\text{MeV}}{c^2}$$

A potential strength of this numeric formula is that if we knew all the quantum numbers “allowed” by Nature, then we could predict the existence of new particles that the Standard Model does not predicts. Using quantum numbers rather than the masses of particles seems to simplify the problem of finding the masses of undiscovered particles. Another point to observe is that between the proton and the neutron there is only one possible quantum number, which is 2. However since no particles have been observed with a mass between the mass of the proton and that of the neutron, the quantum number 2 seems to be forbidden. This indicates that the “granularity” of the formula is correct meaning that we shall not miss out any particle if we increase any quantum number by 1. Having said that I must say that the problem of finding all the “allowed” quantum numbers might not have a solution or might be extremely difficult to solve. We simply don't know. However it would be a very rewarding work to be able to solve it. Finally, the formulation presented in this paper suggests the existence of a more general formula for the masses of all known particles.

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