Numeric Formula for the Masses of Baryons
(Draft Version)

Rodolfo A. Frino - November 2014
Electronics Engineer – Degree from the National University of Mar del Plata - Argentina
rodolfo_frino@yahoo.com.ar

Abstract

A numeric formula for the masses of composite particles made of three quarks is presented. The formula, which uses "discontinuous" quantum numbers, predicts the masses of 13 baryons and one lepton (the tau particle), with an accuracy of, at least, 3 decimal places. The maximum accuracy of the formula is 5 decimal places. The formula suggests the existence of a general formula for the mass of all known particles, which is yet, to be discovered.

Keywords: *quark, lepton, baryon, pentabaryon, Higgs mass, fine-structure constant, quantum number, CODATA.*

1. The Baryon Mass Formula

The formula for the masses of composite particles made of three quarks (baryons - see note 1) is

$$m \approx \left(\sqrt[8]{\frac{n}{\alpha}}\right)\sqrt{m_{H*}\times m_e} \qquad (1)$$

where

$m =$ predicted baryon mass
$n =$ "discontinuous" quantum number
$\alpha =$ fine-structure constant
$m_{H*} = 224.407\ 763\ 2\times 10^{-27}\,Kg$ ("Higgs*" mass)
$m_e = 9.109\ 382\ 91\times 10^{-31}\,Kg$ (electron rest mass) (CODATA 2010)

The "Higgs*" mass was calculated solving eq. (1) for m_{H*} and taking: $m = m_p$ (the mass of the proton) and using a value of 256 for the quantum number *n*. Therefore equation (1) is "calibrated" for the proton mass. This is the reason why the formula yields the mass of the proton with an accuracy of 9 decimal places. The fact that the measured value of the Higgs mass could be different (probably lower) than the value presented here does not matter. The value we adopted is the value that allow us to use the quantum numbers shown on table 1 (this is the reason of using the asterisk). If we change the value of the Higgs mass we have to change not only the quantum numbers but also the form of equation (1) if we are to maintain the target accuracy. Equation (1) can also be written as:

$$m \approx \left(4.521\ 300\ 966 \times 10^{-28}\right)\left(\sqrt[8]{\frac{n}{\alpha}}\right) \tag{2}$$

Note 1: 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.

2. Results

The results of equation (1) for selected quantum numbers are shown on table 1. The table shows that the formula also works for the heaviest lepton: the tau particle (tauon).

Particle name	Symbol	Quark content or lepton	Observed rest mass (*MeV/c^2*)	Observed rest mass (*Kg*)	Quantum number (*n*)	Predicted mass *m* (*Kg*) (Equation 1)
proton	p	uud	938.272	1.672621717E-27	256	1.672621777E-27
neutron	n	udd	939.5653	1.674927292E-27	258	1.674249641E-27
Lambda 0	Λ0	uds	1115.683	1.988885514E-27	1023	1.988850805E-27
Sigma +	Σ+	uus	1189.37	2.120244517E-27	1707	2.120298184E-27
Sigma 0	Σ0	uds	1192.642	2.126077387E-27	1745	2.126141576E-27
Sigma −	Σ−	dds	1197.449	2.134646642E-27	1802	2.134701226E-27
Delta ++	Δ++	uuu	1232	2.196239391E-27	2262	2.196237619E-27
Delta +	Δ+	uud	1232	2.196239391E-27	2262	2.196237619E-27
Delta 0	Δ0	udd	1232	2.196239391E-27	2262	2.196237619E-27
Delta −	Δ−	ddd	1232	2.196239391E-27	2262	2.196237619E-27
Xi 0	Ξ0	uss	1314.86	2.343950752E-27	3800	2.343369110E-27
Xi −	Ξ−	dss	1321.71	2.356161985E-27	3969	2.356149745E-27
Omega −	Ω−	sss	1672	2.980610603E-27	26000	2.980158891E-27
Tau [1]	τ	lepton	1776.821	3.167471000E-27	42341	3.167472770E-27

Table 1: *The last column of the table shows the predicted mass for thirteen baryons and for a lepton: the tau particle (last row). The decimal places shown in white indicate that these places coincide with the corresponding places of the observed values.*

3. Conclusions

The equation introduced in this paper predicts the masses of 13 baryons and one lepton: the tau particle, with an accuracy of, at least, 3 decimal places. Without taking into account the calibration value, the maximum accuracy of the formula is 5 decimal places. The formula suggests that there could exist a general formula for the mass of all known particles and that this unknown formula could be a function of the fine-structure constant and, at the same time, of several different quantum numbers.

REFERENCES

[1] NIST 2010, *Fundamental Physical Constants—Extensive Listing,* retrieved from http: //physics.nist.gov/constants, (2010).