Numeric Formula for the Masses of Baryons

A numeric formula for the masses of composite particles made of three quarks (baryons) is presented. The relationship, which uses "allowed" quantum numbers, predicts the masses of 16 baryons (including 2 baryon resonances) and one lepton: the tau particle, with an accuracy of, at least, 3 decimal places. The maximum accuracy of the formula is 7 decimal places and corresponds to the two new Ξ_b^- *baryon resonances recorded by the LHCb experiment at CERN. The relationship presented in this paper suggests the existence of a general formula for the mass of all known particles, which is yet, to be discovered.*

by Rodolfo A. Frino

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1. The Baryon Mass Formula

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

$$m \approx \frac{1}{2} m_p \sqrt[8]{n} \qquad (1)$$

where

$m =$ predicted particle rest mass (for all particles heavier than the proton)
$m_p =$ proton rest mass
$n =$ "allowed" or "discontinuous" quantum number

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 the “allowed” quantum numbers (or selected quantum numbers) are shown on table 1. The table shows that the formula also works for the heaviest lepton: the tau particle (tauon).

P	PARTICLE NAME	SYMBOL	QUARK CONTENT OR LEPTON	OBSERVED REST MASS (*MeV/c^2*)	OBSERVED REST MASS (*Kg*)	ALLOWED QUANTUM NUMBER (*n*)	PREDICTED MASS *m* (*Kg*) (Equation 1)
1	Proton	p	uud	938.272	1.6726217771E-27	256	1.672621777E-27
2	Neutron	n	udd	939.5653	1.674927292E-27	258	1.674249641E-27
3	Lambda 0	Λ0	uds	1115.683	1.988885514E-27	1023	1.988850805E-27
4	Sigma +	Σ+	uus	1189.37	2.120244517E-27	1707	2.120298184E-27
5	Sigma 0	Σ0	uds	1192.642	2.126077387E-27	1745	2.126141576E-27
6	Sigma −	Σ−	dds	1197.449	2.134646642E-27	1802	2.134701226E-27
7	Delta ++	Δ++	uuu	1232	2.196239391E-27	2262	2.196237619E-27
8	Delta +	Δ+	uud	1232	2.196239391E-27	2262	2.196237619E-27
9	Delta 0	Δ0	udd	1232	2.196239391E-27	2262	2.196237619E-27
10	Delta −	Δ−	ddd	1232	2.196239391E-27	2262	2.196237619E-27
11	Xi 0	Ξ0	uss	1314.86	2.343950752E-27	3808	2.343985219E-27
12	Xi −	Ξ−	dss	1321.71	2.356161985E-27	3969	2.356149745E-27
13	Omega −	Ω−	sss	1672	2.980610603E-27	26031	2.980602818E-27
14	Tau [1]	τ	Lepton	1776.821	3.167471000E-27	42341	3.167472770E-27
15	Xi0b [2]	Ξ_b^0	usb	5791.80	10.32480871E-27	539652420	10.32480879E-27
16	Xi'-b [2] (state with spin 1/2)	$\Xi_b^{'-}$	dsb	5935.02	10.58013370E-27	656126000	10.58013373E-27
17	Xi*-b [2] (state with spin 3/2)	Ξ_b^{*-}	dsb	5955.33	10.61633956E-27	674305000	10.61633951E-27

Table 1: *The last column of the table shows the predicted mass for sixteen baryons and one lepton: the tau particle. The digits (including the decimal places) shown in green indicate that these digits coincide with the corresponding digits of the observed values. The calibration value, corresponding to the proton mass, is shown in black. It is worthy to observe that the* Ξ_b^0 *baryon is about 6.17 times as massive as the proton. The first column is the particle number, P.*

The graph of equation (1) is shown on figure 1.

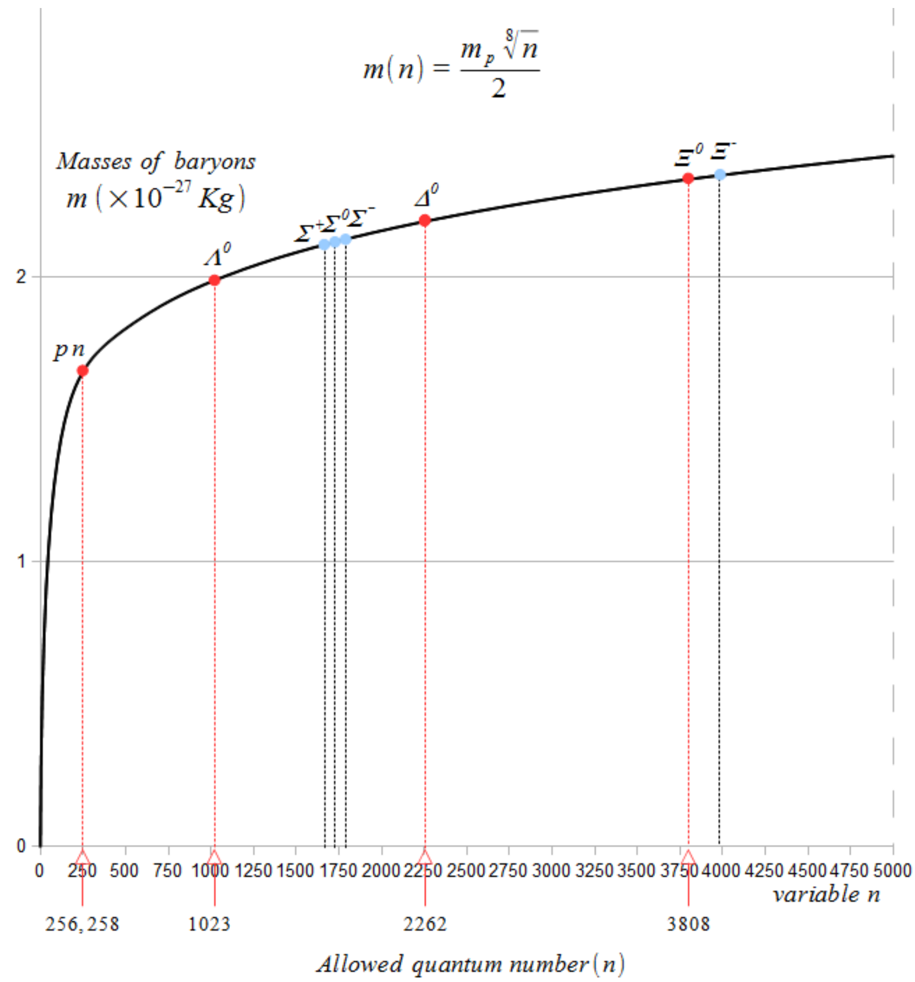

FIGURE 1: Graph of the function for the masses of baryons (equation 1). For practical reasons, the graph shows all particles with quantum numbers smaller than 5,000.

3. Conclusions

The equation introduced in this paper predicts the masses of 16 baryons (without counting the calibration value which corresponds to the proton) and one lepton: the tau particle. The accuracy of the formula is, at least, 3 decimal places. Without taking into account the calibration value, the maximum accuracy of the formula is 5 decimal places. In fact the formula is valid for all particles heavier than the proton. The formula suggests that there could exist a similar formula for the masses of all known particles.

REFERENCES

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