# An unifying equation for almost all constituent quarks masses, of cold and hot genesis

**Author: Arghirescu Marius**

**Abstract**:

Based on a Cold Genesis pre-quantum theory of particles and fields, (C.G.T.), based on Galilean relativity, which explains the constituent quarks and the resulted elementary particles as clusters of negatron-positron pairs ($\gamma(e^-e^+)$) forming basic $z^0$ -preons of ~34 $m_e$ representing the CGT's prediction for the subsequent discovered boson X17, which generate preonic bosons $z_2(4z^0)$ and $z_\pi(7z^0)$ and constituent quarks in a preonic model, from two equations, one for the preonic quarks (u, d, s) and another for the heavy quarks (c-charm and b-bottom), a single unitary equation is obtained for the both mass variants: CGT/Souza and Standard Model, by using four parameters representing integer numbers from 0 to 3: ($k_1$ ; $k_2$) ≤ 3 (for the number of $z_2$- and $z_\pi$- preonic bosons); f = (1;2)- flavor number; n = (1÷4) –compositeness number, and a multiplication factor depending on n, n=4 giving a predicted quark, of mass ~15 GeV/$c^2$.

**Keywords**: preons; quarks; flavor; cold genesis; unitary equation; Standard Model

## Introduction:

In the Standard Model (S.M.), the constituent quark model considers a valence current quark (u-up, d-down, s-strange) or (c-charm, b-bottom, t-top) with a current mass [1]: (1.8÷2.8; 4.3÷5.5; 92÷104) MeV/$c^2$, respective: (1.27; 4.18÷4.7; 173) GeV/$c^2$ 'dressed' by a gluonic shell formed by gluons and sea-quarks [1], the resulting effective quark mass being the constituent quark mass: $m_u$ = 336, $m_d$ = 340, $m_s$ = 486 (MeV/$c^2$) respective: $m_c$ = 1.55, $m_b$ = 4.73, $m_t$ = 177 (GeV/$c^2$). The electric charge of u-, c-, t- quarks is +($^2/_3$)e and the electric charge of d-, s-, b- quarks is –($^1/_3$)e, the strong interaction of quarks being explained by so-named "color charge", the gluons having two opposed color charges, the gluon field between a pair of color charges forming a narrow flux tube (as a string) between them, (Lund's string model [2]).

The constituent quark model is more of a phenomenological approach rather than a theory with specific equations for quark masses. This quark model doesn't provide a specific equation for quarks masses but rather assigns effective masses to quarks based on the hadrons they form.

So, the constituent quark masses are effective masses used in non-relativistic quark models to describe the properties of hadrons, being approximate values that incorporate effects like the quark binding energy of quarks within hadrons, used to fit experimental data on hadron properties, and they were calculated from hadrons masses assuming additivity.

However, there are models like the MIT bag model [xx] that provide insights into how quark masses and the strong force binding energy contribute to the overall mass of hadrons.

The MIT bag model, for example, considers quarks confined in a "bag," and the mass of a hadron is given by a combination of the quark masses and the energy of the bag, i.e.:

$M_q \approx \sum_i m_{qi} + B{\cdot}V$, $m_{qi}$ representing the masses of the constituent quarks, the bag energy $B{\cdot}V$ (given by the bag constant B and the hadron's volume) accounting for the energy associated with the strong force confining the quarks within the hadron.

In the relativistic chiral quark model [xx], the 'valence' quarks are very strongly bound, (their wave function falling off as $\exp(-r/0.6\ \text{fm})$) and about 2/3 of the quark mass $M \simeq 350$MeV is eaten up by interactions with the classical pion field, relativistic effects being thus essential.

Also, the fact that the mass of π- mesons ('pions') considered as ($u\ \bar{d}$)-pairs, is almost 1/5 of the sum of u- and $\bar{d}$- quarks effective masses, is explained in the S.M. by the conclusion that its mass is given by the current masses of their quarks and their binding energy.

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In a Cold Genesis pre-quantum theory of particles and fields, (C.G.T., [9-12]), based on Galilean relativity, it results- as a more natural alternative, the possibility to explain the constituent quarks and the resulted elementary particles as formed by quasi-stable basic $z^0$-preons of ~34 $m_e$ generated 'at cold', as clusters of negatron-positron pairs named 'gammons' in CGT: ($\gamma(e^-e^+)$), resulting that preonic quarks can be formed 'at cold' by heavier preonic bosons, as Bose-Einstein condensate of 'gammons', in accordance to the sum rule and to the total mass/energy conservation law, (M. Arghirescu, 2006, [9], p. 58).

The considered "gammons" were experimentally observed in the form of quanta of "un-matter" plasma, [15].

The existence of $z^0$ -preon was deduced by calibrating the value: $m_k = m_e/2\alpha = 68.5m_e$ obtained by Olavi Hellman [13], by using the masses of the proton and the Σ-baryon, [9].

The existence of a neutral boson having a mass of ~34 $m_e$ was experimentally evidenced by a research team of the Science' Institute for Nuclear Research in Debrecen (Hungary), [14], which evidenced a super-light particle with a mass of ~17 MeV/$c^2$, (~34 $m_e$), named X17, by a reaction:

$$Li7 + p^+ \rightarrow Be^* \rightarrow Be8 + b^0\ ; \qquad b^0 \rightarrow e^+ + e^-\ , \qquad m(b^0) \approx 34\ m_e\ , \qquad (1)$$

that was explained in CGT by the conclusion that the $z^0$-preon is composed by two 'quarcins', $c_0^{\pm}$, its stability being explained in CGT by the conclusion that it is formed as a cluster of an even number n = 7x6 = 42 quasielectrons, (integer number of degenerate "gammons", $\gamma^*(e^{*-}\ e^{*+})$), with mass $m_e^* \approx 34/42 = 0.8095\ m_e$, i.e. reduced to a value corresponding to the charge $e^* = \pm(^2/_3)e$ by a degeneration of the magnetic moment's quantum vortex $\boldsymbol{\Gamma_\mu} = \boldsymbol{\Gamma_A} + \boldsymbol{\Gamma_B}$ generated around superdense centroids and given by 'heavy' etherons of mass $m_s \approx 10^{-60}kg$ and 'quantons' of mass $m_h = h{\cdot}1/c^2 = 7.37\text{x}10^{-51}$ kg.

The predicted mass of the $z^0(34m_e)$ -preon is in the tolerance limits of the experimentally determined mass of X17-boson: $m_{(X17)} = (16.95 \pm 0.48(\text{stat.}) \pm 0.35(\text{syst.})$ MeV/$c^2$, obtained also by experiments of Giant Dipole Resonance (GDR) of $^8$Be [x1]. It was assumed that the X17 particle was created in the decay of GDR to both the ground state and to the first excited state, based on the energy of that transition (17.5 MeV).

Very recently, Barducci and Toni published an updated view on the ATOMKI nuclear anomalies [x2] and they have critically re-examined the possible theoretical interpretation of the observed anomalies in 8Be, 4He and 12C nuclei in terms of a beyond standard model boson X with mass ≈17 MeV.

In Ref. [x3] the boson X17 was considered as mediator partner of the nuclear force.

Indeed, in the S.M.'s quark model, its mass can be considered as given by: (3+5.5)2 = 17 MeV-c2, so the gluonic shell of the valence quarks can be regarded as containing X17-bosons with role of gluons, in the S.M.

In CGT, the fractional charge of quarks is given by a quasielectron –for $e^* = \pm(^2/_3)e$ , and by a quasielectron and an electron with degenerate mas, magnetic moment, attached to a neutral cluster of paired quasi-electrons.

The light and semi-light cold quarks which give the masses of the astro-particles results in CGT as superpositions of preonic bosons $z_2 = 4z^0$ and $z_\pi = 7z^0$ with almost the same symmetry ('star' and hexagon, figure 1, [10;16]), conform to a constituent quark' mass equation of the form:

$$M_q = M(m_{1,2}) + k_1 \cdot z_\pi + k_2 \cdot (k_1 - 2) \cdot z_2 ; \quad m_{1,2} = (m_1^+; m_2^-) \ ; \ k_1 = 0 \div 3); \ k_2 = 0 \div 2 < k_1 \qquad (2)$$

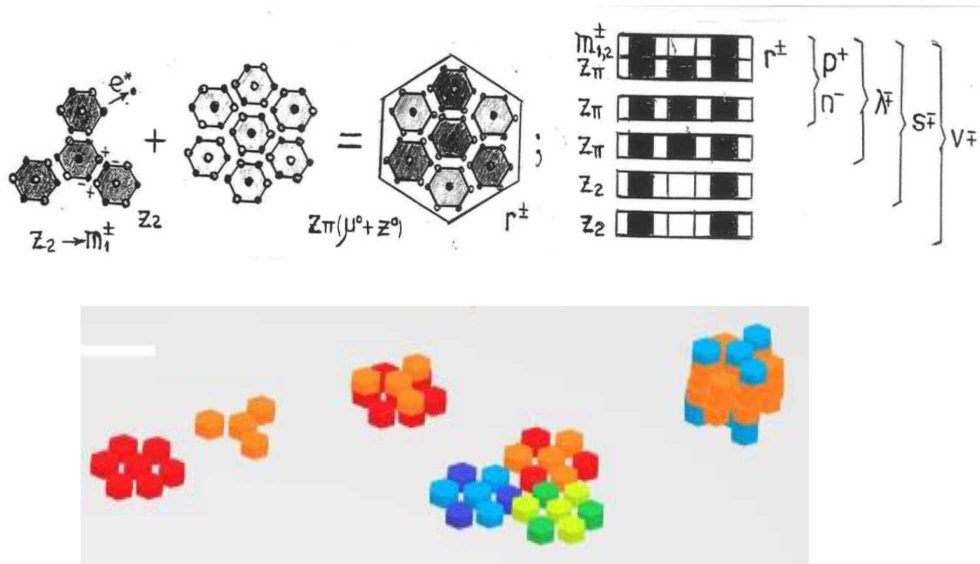
i.e: -($k_1$ , $k_2$ = 0) ⇒ $q = m_{1,2}$ ; ($k_1 = 1, k_2 = 0$ ) ⇒ $q = r^{\pm}$ , ("rark"- un-stable quark); ($k_1 = 2$) ⇒ $q = p^+, n^-$; - ($k_1 = 3, k_2 = 0$) ⇒ $q = \lambda^{\pm}$; ($k_1 = 3, k_2 = 1$ ) ⇒ $q = s^{\pm}$; ($k_1 = 3, k_2 = 2$) ⇒ $q = v^{\pm}$, ($k_1$; $k_2$) – clustering numbers).

From eq. (2), the baryons mass results as combinations (q-q-q) and the mesons- as combinations (q- $\bar{q}$), in the form:

$$M_b = M_q + k \cdot z_\pi + n \cdot (k - 6) \cdot z_2 ; \quad M_q = \sum_{i=1}^{3} m_i \ ; \ m_i = (m_1^+; m_2^-); \quad k = 6 \div 9; \ n \leq 2 \qquad (3)$$

The particle's mass results by eq. (2) in the approximation of the sum rule applied to the particle's cold forming, as consequence of the quantum fields' superposition principle applied to the particle's cold forming as sum of degenerate electrons, whose total vortical field $\Gamma_v$ can explain also the nuclear force $F_n = -\nabla V_n(r)$, [10, 16].

Conform to this model, the mentioned preonic bosons $z_2$ and $z_\pi$ are detectable when they are released in strong interaction or quark's transforming weak interactions as gamma –quantum with specific energy > 1MeV. For example, the gamma quantum resulted in the transforming reaction: $\pi^0 \rightarrow 2\gamma$ represent a $z_2$(136 $m_e$) –boson, and the gamma quantum emitted in the nuclear reaction: $^7Li + p \rightarrow 2\alpha + \gamma(17.2\ MeV)$ , (used by Cockcroft and Walton (1932) for verify the formula: $E = mc^2$ and founding that the decrease in mass in this disintegration process was consistent with the observed release of energy), represents –according to CGT, a released basic preon $z^0$(17.37MeV).



a)

b)

**Fig. 1 a,b.** *The cold forming of semi-light quarks from $m_{1;2}$ light quark and $z_2$- , $z_\pi$ -preonic bosons, (3D)*

For the constituent quarks heavier than the nucleonic quarks it resulted in CGT as more plausible the mass values $m_q^s$ found by M. de Souza for the baryonic quarks s, c and b, i.e.: [18]: (0.5; 1.7; 5) GeV/c$^2$, for which it was found by CGT the next generating mechanism in CGT [17]:

a) $m_s^* = 987.8\ m_e$, ~0.504GeV/c$^2$ ≈ $m_s^s$ = 0.5 GeV/c$^2$ = 978.5 $m_e$ -the mass of s-quark;
(m$^*$ -the mass of the constituent cold quark, specific to CGT),

b) $m_c$ = 1.7 GeV/c$^2$ = 3326.8 $m_e$ –charm quark's mass used by de Souza [18], and:

c) $m_b$ ≈ 5 GeV –bottom quark's mass used by de Souza [18], resulting in CGT as tri-quarks clusters, by de-excitation reactions (with the released mass proportional to the quarks' binding energy), of the form:

$$c^{*\pm}\left[v^{\pm}\overline{\cdot v^{\pm}\cdot} v^{\pm}\right] \rightarrow c^{\pm} + z^0(34m_e) \tag{4a}$$

$$b^{*\pm}\left[c^{\pm}\overline{\cdot c^{\pm}\cdot} c^{\pm}\right] \rightarrow b^{\pm} + z_3(204m_e); \quad (z_3 = z_\mu = (2\text{x}3)z^0 = 2z_1) \tag{4b}$$

d) $m_t$ ≈ 175 GeV, the t-quark's mass, with current mass resulting in CGT as prismatic cluster:

$$t^{\pm} = (7\text{x}5)m(b^{\pm}) = (17(b\bar{b}) + b^{\pm}), \quad \text{(super-heavy quark)} \tag{5}$$

The masses $m_c$ and $m_b$ (of quarks charm and bottom- Eqs. (4)) were obtained in CGT by Eq.:

$$M_n^{¤}(q_n) \approx M_1 \cdot 3^{n-1}\ ; \quad q_n = [(q\bar{q})q]_{n-1} \tag{6}$$

obtained by Karrigan Jr. [19] for quarks of the S.M., (for masses: $M_2^\bullet = m_c^\bullet$ = 1.55 GeV/c$^2$ and: $M_3^\bullet = m^\bullet_b$ = 4.73 GeV/c$^2$ , with: $M_1^\bullet(q_1) = m_s^\bullet$ ≈ 0.486GeV/c$^2$), but modified by Eqs. (4) in the form:

$$M_n(q_n^c) \approx 3^{n-1}\left[M_1 - \frac{z^0}{3}(2n-3)\right],\ (n > 1); \tag{7a}$$

(n- compositeness number; $M_1 = m_v$ = 574 MeV/c$^2$). Eq. (7a) gives: $m_c$ = 1704.6 MeV/c$^2$ and: $m_b$ ≈ 5009.6 MeV/c$^2$.

By taking into account and the loosing of some internal bosons (photons –in CGT and gluons in the S.M.) corresponding to the binding energy between the current $q^{n-1}$-quarks during the composite $q_n^c$ –quark' forming, its $M_n$- mass results closer to the value deducted by M. de Souza by writing: (2n-3) as: $\ln(e^{2n-3})$ and replacing e = 2.718 with 3, i.e. in the approximated form:

$$M_n(q_n^c) \approx 3^{n-1}\left[M_1 - \frac{z^0}{3} ln(3^{2n-3})\right] \quad (7b)$$

(with $M_1 = m_v^* \approx 1121.2\ m_e \approx 0.574$ GeV -the mass of cold v-quark of CGT, instead of $m_s^\bullet$), and by considering the resulting quarks: $c(m_c^+)$ and $b(m_c^-)$ as de-excited states of the triplet $m_n^\wedge$ with mass: $m_4^* = m(c^*) = 3m_v^*(v^+) = 3363.6\ m_e$, (1.718 GeV/$c^2$), and respective: $m_5^* = m(b^{*\pm}) = 3m_c \approx 5.1$ GeV/$c^2$, ($q^*$ -'cold' quark).

Eq. (7b) gives: n = 2 → $m(q_2^c)c^2 = 1.703$ GeV; n = 3 → $m(q_3^c)c^2 = 4.994$ GeV ≈ 5 GeV;
n = 4→ $m(q_4^c)c^2 = 14.64$ GeV, (prediction).
The quarks of the S.M. result from ($5^a$) as de-excited quarks of CGT: $s^-$, $c^+$, $b^-$, by the reactions:

$$s(504) \to s^\bullet(486) + z^0;\ c(1704) \to c^\bullet(1565) + \pi^0(2z_2);\ b(5009) \to b^\bullet(4766) + z_6(2z_\pi) \quad (8)$$

For the quarks $c^\bullet$ and $b^\bullet$ the previous reactions (8) correspond to an equation having- by n = 2 and n = 3, the approximated form:

$$M(q_n^\bullet) \approx 3^{n-1}\left[M_1 - [\delta^\bullet - \frac{z^0}{k_p}(n-2)]\right] \quad ; \quad k_p \approx 2.3 \quad (9a)$$

with: $(M_1 - \delta^\bullet) = (2m_s + m_v - z^0)/3] = 521.5$ MeV/$c^2$, ( $\delta^\bullet = 3z^0 = 52.45$ MeV/$c^2$) (9b)

(taking into account in (9b) the Eq. (4a) of the c-quark's obtaining and figure 1a), which gives:
$m_c^\bullet(c^\bullet) = 1564.5$ MeV/$c^2$; $m_b^\bullet(b^\bullet) = 4762$ MeV/$c^2$.

These values are obtained by Eqs. (8) and (9) with a discrepancy under 1%, (~0.9%, respective: 0.7%), compared to the experimentally obtained values: $m_c^\bullet$ (1550) and $m_b^\bullet$(4730).

The experimental values: $m_c^\bullet = 1.55$ GeV/$c^2$ and $m_b^\bullet = 4.73$ GeV/$c^2$ can be obtained from a modified form of Eq. (9b), by taking into account and the loosing of some internal bosons of the bosonic shell (photons –in CGT) corresponding to the binding energy between the current $q^{n-1}$-quarks during the composite $q_n^c$ –quark' forming, i.e. taking $\delta > \delta^\bullet$ instead of δ.

For an unifiable expression, we can choose a form similar to Eq. (7b) by writing in Eq. (9a): $\ln e^{n-2}$ instead of (n-2) and replacing e = 2.718 and $k_p$ with 3, resulting for $M_n^c(q_n^\bullet)$ the approximated form:

$$M_n^c(q_n^\bullet) \approx 3^{n-1}\left[(M_1 - (\delta - \frac{z^0}{3}\ln 3^{n-2})\right] ; \quad (\delta = 55\ \text{MeV}/c^2 > \delta^\bullet) \quad (9c)$$

the value δ = 55 MeV/$c^2$ being obtained by taking: $M_n^c(n = 3) = 4730$ MeV/$c^2$ (the known experimental value of $m_b^\bullet$).
For n = 2, Eq. (9c) gives: $M(q_2^\bullet)c^2 = 1557$ MeV ≈ $m(c^\bullet)$, so a value also almost equal to the known experimentally determined mass of the of the constituent charm- quark, (1.55 GeV/$c^2$).

From Eqs. (7b) and (9c), it was obtained [20] a single equation for the masses of the composite constituent quarks, of cold genesis (Souza/CGT variant) and of hot genesis (S.M.'s variant), in the form:

$$M(q_n^f) = 3^{n-1}\{m_v - (2-f)\delta - (z^0/3)\ln[3^{(2n-3)}/3^{(2-f)(3n-5)}]\} \qquad (10)$$

in which: $m_v = m(v^{\pm}) \approx 574$ MeV/c$^2$; $\delta = 55$ MeV/c$^2$ and $f = f_q =$ ($f_1 = 1$; $f_2 = 2$) –'flavor' numbers of composite quarks $q_n^{\bullet}$(S.M.) and $q_n^s$ (CGT), (named 'quarkonics', in CGT [20]).
Eq. (10), by $f = |f_q| = 1$ retrieves Eq. (9c) for $M(q_n^{\bullet})$ and by $f = |f_q| = 2$ it retrieves Eq. (7b) for $M(q_n^s)$ .

## 2. The obtaining of a single equation for almost all composite quarks masses

The possibility to unify the equations (2) and (10) in a single equations for all light, is to write in Eq. (10) the Eq. (2) instead of $m_v$ and: $(z^0 + \beta)$ instead of $\delta$, ($\beta = 37.63$ MeV/c$^2$), and to multiply the last part of Eq. (10) with $|\alpha_q|$, $\alpha_q$ being the sum: $\alpha_q = (2n - 1 - 2^{n-1})$, which gives: $\alpha_q = 0$ for n = 1, $\alpha_q = 1$ for n = 2 or 3 and $|\alpha_q| = 1$ for n = 4. It results the equation:

$$M_q(q_n^f) = 3^{n-1}\left\{[M_{1,2} + k_1\cdot z_\pi + k_2\cdot(k_1-2)\cdot z_2 - z^0(2-f)] - [\beta(2-f) + \frac{z^0}{3}\ln\frac{3^{(2n-3)}}{3^{(2-f)(3n-5)}}]\cdot\left|2n-1-2^{(n-1)}\right|\right\}; \qquad (11)$$

$$M_{1,2} \approx (1/\alpha)\,m_e;\;\; k_1 = 0 \div 3;\;\; k_2 = 0 \div 2 < k_1;\;\; f = (1;2);\;\; n = 1 \text{ if } (k_1 + k_2) < 5;\;\; n = 1 \div 4 \text{ if } (k_1 + k_2) = 5$$

($M_{1;2} = M(m^{\pm}) = \left(1/\alpha - 0.5 \pm 1.3\right)m_e \approx 69.5$ MeV/c$^2$; ($\alpha = 1/137$); $\beta = 37.63$ MeV/c$^2$;
f = 1- for S.M.'s variant, (being applicable only for $k_1 > 2$); f = 2- for Souza/CGT variant.

It is observed that for n = 1 it is retrieved Eq. (2) for the preonic quarks, (light and semi-light), and for $(k_1 + k_2) = 5$; n >1, it is retrieved Eq. (10) .

Also, taking $e^{(2n-3)}/e^{(2-f)(3n-5)}$ instead of $3^{(2n-3)}/3^{(2-f)(3n-5)}$ there are obtained –with f = 1; 2, the Eqs. (7a) and (9a) -with $k_p = 3$, corresponding to the de-excitation reactions (4) and (8) and to the sum rule.

- The differences per $m_v$-quark resulting between Eqs. (7a) and (7b):
$\Delta_q = (z^0/3)[\ln 3^{(2n-3)} - (2n-3)] > 0$ can be explained in CGT as loosed mass of internal bosons (naked photons- in CGT) by the conclusion that a bigger mass of composite $q_n$- quark imply an increasing binding energy between their current $q_{n-1}$ (smaller quarks) for a higher n, determined by a higher vortical attractive force per v-quark and an increased quantity of loosed internal photons per v-quark, at their confining into a composite quark.

- The difference per $m_v$-quark resulting between Eqs. (9a) and (9c):
$\Delta_q^{\bullet} = \{[\delta - \delta^{\bullet}] - [(z^0/3)\ln 3^{(n-2)} - (z^0/2.3)(n-2)]\} > 0$, can be explained similarly in CGT by the conclusion that a bigger mass of a composite $q_n^{\bullet}$ -quark formed by de-excitation of its

metastable state $q_n$ imply and the loosing of a mass of internal bosons per v-quark: [δ-δ•] ≈ 2.55 MeV/$c^2$, which is a little increased for n = 3, (with ~1.2 MeV/$c^2$ per v-quark).

The current masses of quarks results in CGT [21] according to a semi-empiric relation inspired by the proportionality: $M_p^2 \sim (m_{q1} + m_{q2})$, specific to the Gell-Mann-Oakes-Renner relation [22]- used for the obtaining of the current mass of s•-quark, resulting as ansatz in the form:

$$m_q = M_q - \Delta_q = M_q - A_q \cdot e^{k_q \cdot \left(1 - \frac{M_{s\bullet}^2}{M_q^2}\right)}\ MeV/c^2; \qquad (12)$$

with $M_{s\bullet} = M_s^\bullet$(486MeV) – the constituent mass of s• –quark. The constants $A_q$, $k_q$, were obtained by: $m_{u;d}$ = 7.5 MeV/$c^2$ ; $m_{s\bullet}$ = 91 MeV/$c^2$ –values obtained in CGT [21], resulting that:

$A_q = \Delta_{s\bullet} = 395$ MeV/$c^2$ ; $k_q = 0.182$, and: $m_{c\bullet}'$ = 1091 MeV/$c^2$ , $m_{b\bullet}'$ = 4257 MeV/$c^2$.

The exponential variation of $\Delta_q$ conform to Eq. (12) is explainable in CGT by the superposition of more quantonic $\Gamma_\mu$-vortices of the degenerate electrons' magnetic moments, for increased $M_q$ –masses formed by $z^0$-preons, which determine the generating of a stronger attractive force over the kerneloids of the thermalized photons of the bosonic shell of quarks, part of them increasing the mass of the quark's kerneloid, (i.e. of its current mass, conform to CGT, [21]).

It results from Eqs. (11) and (12) the next Table, (d-quark = de-excited quark).

Table 1 : The theoretic masses of quarks in variants: S.M.'s and Souza/CGT, (Eq. (11))

| Quark/index (d= de-excited) | n | $k_1$ | $k_2$ | f | Constituent mass MeV/$c^2$ | Known SM's mass MeV/$c^2$ | Current mass MeV/$c^2$ CGT/(SM) | Variant |
|---|---|---|---|---|---|---|---|---|
| mark, ($m_{1;2}$) | 1 | 0 | 0 | 2 | 69.1; 70.4 | | ≈ 1.(6) | CGT |
| rark ($r^\pm$, un-stable) | 1 | 1 | 0 | 2 | 191.6 | | 3 | CGT |
| park/nark, (p; n) (u/d) | 1 | 2 | 0; 1 | 2 | 312; 313 | 336; 340 | 7.5 (3÷6) | CGT; SM |
| lark, λ | 1 | 3 | 0 | 2 | 435 | | 57.4 | CGT |
| d-lark, λ• | 1 | 3 | 0 | 1 | 417.6 | | 47.2 | CGT |
| sark, s | 1 | 3 | 1 | 2 | 504 | | 104 | CGT |
| strange, s• | 1 | 3 | 1 | 1 | 486.6 | 486 | 91;/(90÷130) | S.M. |
| vark, v | 1 | 3 | 2 | 2 | 574 | | 158 | CGT |
| d-vark, v• | 1 | 3 | 2 | 1 | 556.6 | | 144.14 | CGT |
| chark, c | 2 | 3 | 2 | 2 | 1700 | | 1233 | CGT |
| charm, c• | 2 | 3 | 2 | 1 | 1557 | 1550 | 1091; (1180÷1340) | SM |
| bark, b | 3 | 3 | 2 | 2 | 5000 | | 4527 | CGT |
| bottom, b• | 3 | 3 | 2 | 1 | 4728 | 4730 | 4257; (4130÷4340) | SM |
| fark, $f_q$ (b $\bar{b}$b) | 4 | 3 | 2 | 2 | 15000 | - | 14526 | CGT, pred. |
| d-fark | 4 | 3 | 2 | 1 | 14356.5 | - | 13882 | CGT, pred. |

It must be mentioned that also the Standard Model uses two massic variants of the constituent quarks, for baryons the constituent mass being higher than that known for mesons and of value depending on the chosen model, for example [23]:
$M_{u/d}$ = 362 MeV/$c^2$; $M_s$ = 540 MeV/$c^2$; $M_c$ = 1710 MeV/$c^2$; $M_b$ = 5044 MeV/$c^2$, the difference being explained by the conclusion that the mass of the strange quark, in presence of a heavy antiquark, is smaller, [23], (for example: 308 MeV/$c^2$ –for the u/d- quark, instead of 336÷362 – in the baryons' case, [23]).

### 3. The correspondence of CGT's model with the Gell Mann-Oakes-Renner relation

Because in CGT the sum rule can be used and for the obtaining of the particle's mass as sum of masses of its basic $z^0$-preons, it can be used a linear proportionality between the particle's mass $M_p$ and the total volume of its current quarks ($\upsilon_{q1} + \upsilon_{q2}$) at a given internal temperature $T_i$ , i.e.: $(\upsilon_{q1} + \upsilon_{q2}) \approx n_z\upsilon_{z0} = \upsilon_{z0}(M_p/m_{z0}) \approx k_1M_p$ .

Also, the CGT being constructed as a gauge theory in a classical sense, the used model of composite particle considers a quasi-constant volume $\upsilon_p$ of classic radius a ≈ 1.41 fm, (corresponding to a classic electron with the e-charge contained in its surface) for the astro-particles with mass at most equal to the $\Omega^+$-particle. In this case, it results as logical also the mass-depending increasing of their mean density $\bar{\rho}_p$ and of their current quarks' density proportional to the particle's mass: $\bar{\rho}_q \approx k'\bar{\rho}_p = k'(M_p/\upsilon_p)$.

So, the increasing of the total mass of the particle's current quarks may be approximated also in CGT as being conform to the relation: $M_m^2 \approx B(m_{q1} + m_{q2})$, of Gell-Mann, Oakes and Renner [22], (obtained by extrapolation) between the (π, K,η)-mesons' masses and the masses $m_q$ of their light current quarks, which is explained in CGT by the increasing of the mean value of current quarks' density and of the sum of their volumes proportional to the mass of the pseudo-scalar (π,K,η)-mesons at a given internal temperature $T_i$ , i.e.:

$$(\upsilon_{q1} + \upsilon_{q2}) \approx \upsilon_{z0}(M_p/m_{z0}) = k_1M_p; \quad \bar{\rho}_q = \tfrac{1}{2}(\rho_{q1} + \rho_{q2}) \approx k'(M_p/\upsilon_p) = k_2M_p; \Rightarrow \qquad (13a)$$

$$\Sigma_q m_q = (m_{q1} + m_{q2}) = (\upsilon_{q1} + \upsilon_{q2})\bar{\rho}_q \approx k_1k_2M_p^2 = B^{-1}M_p^2 \qquad (13b)$$

The theoretically obtained ratios: $m_\lambda/ m_m^- = 24.8$ and: $m_s^\bullet/m_m^- = 30.37$ , obtained by CGT's model [20] are concordant with the experimentally obtained masses of mesons $\eta^0(1073\ m_e)_e$ and $K^0(974.5\ m_e)_e$ by the GMOR relation and the Gell-Mann-Okubo relation:

$$3 \cdot M^2(\eta^0)_e + M^2(\pi^0)_e \approx 4M^2(K^0)_e \qquad (14)$$

(verified with discrepancy of ~ 5%), but written in the form :

$$\frac{3\cdot M^2(\eta^0)_e}{4M^2(K^0)_e - M^2(\pi^0)_e} = 0.927 \approx \frac{3(m_{S^\bullet} + m_{\bar{m}}^-)}{4(m_\lambda + m_{\bar{m}}^-) - 2m_{\bar{m}}^-} = \frac{3(m_{S^\bullet}/m_{\bar{m}}^-) + 3}{4(m_\lambda/m_{\bar{m}}^-) + 2} = 0.928\ ; \qquad (15)$$

A lower discrepancy than that of the GMOR relation it results by the relation:

$$3 \cdot [M^2(\eta^0)_e + M^2(\pi^0)_e] \approx 4M^2(K^0)_e \quad (16a)$$

which gives a discrepancy of ~ 3.2 % and which verify the GMOR relation by CGT, i.e.:

$3[(m_{S\bullet}/m_m^-) + 1 + 2] = 100 \approx 4(m_\lambda + m_m^-) = 103.2$, verified by the same discrepnncy,

i.e is verified that:

$$3 \cdot [M^2(\eta^0)_e + M^2(\pi^0)_e]/4M^2(K^0)_e = 3[(m_{S\bullet} + m_m^-) + 2m_m^-]/4(m_\lambda + m_m^-). \quad (16b)$$

It results also –by CGT, that- in concordance with the previous relation, we must have:

$$6 \cdot (M(\eta^0)_e + M(\pi^0)_e) = 8M(K^0)_e + M(\pi^0)_e \quad (17a)$$

because we have –in CGT: $3 \cdot [M(\eta^0)_e + M(\pi^0)_e] = 4M(K^0)_e + M(\pi^0/2)_e$ , i.e:

$$3(M_{S\bullet} + M_m^- + 2M_m^\pm) = 3(29-1+4+8)z^0 = 120\ z^0 \approx 4(M_\lambda^- + M_m^+) = [4(25+4)+4]z^0$$

Indeed, the experimental values of the mesons' masses verify Eq(23d) because we have:

$$3(1073+273) = 4038\ m_e \approx 4(974.5) + 273/2 = 4034.5\ m_e\ . \quad (17b)$$

The values of current quarks masses obtained in CGT verify also the relation used by Weinberg : $\frac{M_\pi^2}{2m_{u,d}} \approx \frac{M_K^2}{m_{s\bullet} + m_u} \approx \frac{M_\eta^2}{m_{s\bullet} + m_d}$ but which in CGT must be written in the form:

$$\frac{M_\pi^2}{2m_{m-}} \approx \frac{M_K^2}{m_\lambda + m_{m-}} \approx \frac{M_\eta^2}{m_{s\bullet} + m_{m-}};\ \Rightarrow\ \frac{135^2}{2x3} \approx \frac{498^2}{74+3} \approx \frac{548.3^2}{91+3} \quad (18)$$

With the experimental masses of the neutral mesons it results for the previous ratios the values: 3038; 3220 and 3198. With the mesons' masses obtained by CGT, it results the ratios: 3182; 3303; 3306.5, so- a lower discrepancy between the first and the second ratio.

## 4. The masses of the mesons and of baryons in CGT

It is known that by the forming of the constituent quarks from current quarks which acquire a bosonic shell (of gluons- in the S.M. and of heavy ‚naked' photons, virtually reduced to their rest mass –in CGT) the baryons' masses result approximately by the sums of their constituent quark masses, [24, 25].

A general semi-empiric equation for the baryons' mass can be written in CGT conform to the sum rule in the form [20]:

$$m(p_b) = \sum_1^3 m(q_k^f) - \delta m_q = \sum_1^3 m(q_k^f) - (n \cdot \tfrac{1}{6}|\sum f_q| + J^p - \tfrac{1}{2}) \cdot z^0\ ; \quad (19)$$

($f = f_q = 2$; $n = 0 \div 2$ for $J^p = ½$ and $n = 0 \div 5$ for $J^p = {}^3/_2$); $\delta m_q / m(p_b) < 2.7\%$); ($f_q$ –quark's flavor).

Because the pseudoscalar mesons have the total angular momentum (total spin) $J^p = 0$ and the vector mesons have $J^p = 1$, it can be written a semi-empiric equation similar to Eq. (15) but considered for $m(p_m) = m(q_k\,\bar{q}_l)$, in the form [20]:

$$m(p_b) = \sum_1^2 m(q_k^f) - \delta m_q = \sum_1^2 m(q_k^f) - (n - |\sum f_q| - J^p)\cdot z^0; \quad (20)$$

$\delta m_q / m(p_m) < 5\%$); $f_q| = [1;2]$ ; $n = 0 \div 8$ for $J^p = 0$ and $n = 0 \div 5$ for $J^p = 1$; $(f_q(\bar{q}) = -f_q(q))$

Eqn. (20) can explain by CGT also the Guadagnini formula [26]:

$$8(m_{\Xi^{*-}} + m_N) + 3m_\Sigma = 11m_\Lambda + 8m_{\Sigma^{*-}}; \quad (21)$$

$\Rightarrow 8(1530 + 939) + 3x1192 \approx 11x1115.36 + 8x1385;$ $\Rightarrow$ 23328 MeV/$c^2 \approx$ 23349 MeV/$c^2$

which is satisfied with less than one-percent discrepancy. In CGT, we have:

$$8x(2v^\bullet + \lambda^\bullet + 2n + p) + 3(v + n + p) \approx 11x(s^\bullet + n + p) + 8(v + s + n); \ (q^\bullet = q - z^0) \quad (22a)$$

$$16v^\bullet + 8\lambda^\bullet = 5v^\bullet + 11s^\bullet + 11z_2 + 8\lambda^\bullet = 5v^\bullet + 11s^\bullet + 3z_2 + 8s^\bullet \approx 5v + 8s + 11s^\bullet;$$

$$5v^\bullet + 3z_2 + 8s^\bullet = 5v^\bullet + 8s^\bullet + 12z^0 \approx 5v + 8s = 5v^\bullet + 8s^\bullet + 13z^0; \ (\Delta_M = 1z^0 = 17.37 \text{ MeV/c}^2)$$

So, the very low discrepancy of Eq. (21) given by the experimental masses ($\Delta_M$ = 21 MeV/$c^2$) is very well explained by the CGT's model of the constituent quarks.

-The differences between the masses of particles (mesons or baryons) of the same multiplet but having different electric charges can be explained by the mass(es) of clusters of linking gammons of square, pentagonal, hexagonal or cubic form: $(2^2 \div 3^2)\gamma^*$ or $(2^3 \div 3^3)\gamma^*$, ($m(\gamma^*) = 2m_e^*$ = 1.62 $m_e$ (~0.828 MeV/$c^2$) formed/acquired by the particles having the charge $e^\pm$ or $2e^\pm$- given by degenerate electron(s) which is/are linked to the particle's neutral cluster by a such gammonic cluster, (which can be considered pseudo-gluons, in this case).

For example, the difference $\Delta_\pi \approx 4.6$ MeV/$c^2$ between the masses of the light mesons $\pi^0$ = 134.97 MeV/$c^2$ and $\pi^-$ = 139.57 can be explained by a quatruplet $\gamma^{4*} = 4\gamma^* = 4x0.828 = 3.31$ MeV/$c^2$ which corresponds to a couple of mesonic current quarks of mass: $m_m \approx$ 1.(6) MeV/$c^2$ , (i.e. to a pair: $(u - \bar{u})_c$ of current $m^+$ -quarks), or by a quintet: $\gamma^{5*} = 5\gamma^* = 5x0.828 = 4.14$ MeV/$c^2$ which bind the meson's electron or positron to the neutral cluster of paired quasielectrons corresponding to the $\pi^0$- meson.

Similarly, the difference $\Delta_K \approx 3.95$ MeV/$c^2$ between the masses of the K-mesons: $K^0$ = 497.61 MeV/$c^2$ and $K^\pm$ = 493.67 can be explained by a quintet: $\gamma^{5*} = 5\gamma^* = 5x0.828 = 4.14$ MeV/$c^2$ which bind a degenerate electron $e^{-*}$ or $e^{+*}$ (with e-charge but with degenerate magnetic moment) to the inversely charged cluster of a $K^+$- or $K^-$- meson formed similarly to a $\pi^\pm$ - meson, in CGT.

It is explained –in this way, also the Dashen's relation: $\Delta^\gamma(\pi^\pm) \approx \Delta^\gamma(K^\pm)$, [27].

Similarly, the differences: ($\Delta_\Sigma \approx 3.16$; $\Delta'_\Sigma \approx 4.9$) MeV/$c^2$ between the masses of the triplet: $\Sigma^+$(1189); $\Sigma^0$(1192.16); $\Sigma^-$(1197), can be explained by the mass of a gammonic clusters: $\gamma^{4*}$, respective: $\gamma^{6*}$ formed by the aid of the vortical field of the particle's magnetic moment (given by its e-charge(s)) as ‚gluonic' cluster, in CGT.

Similarly, the difference: $\Delta_\Xi \approx 8$ MeV/$c^2$ between the masses of the doublet: $\Xi^0$(1314.3); $\Xi^-$(1322.3), can be explained by the mass of a gammonic clusters: $\gamma^{9*} = 3^2\gamma^*$ or $\gamma^{10*} = 2\gamma^{5*}$, in CGT.

Also, the γ-emission reaction of Hf178, ($Hf^{m2}$), which emits γ -quanta of 2-3 MeV/$c^2$ , can be explained in CGT as resulting by the releasing of gammonic $\gamma^{3*}$-triplets or $\gamma^{4*}$-quatruplets from the bosonic shell of some constituent quarks.

## 4. Conclusions

Based on a Cold Genesis pre-quantum theory of particles and fields, (C.G.T.), based on Galilean relativity, which explains the constituent quarks and the resulted elementary particles as clusters of negatron-positron pairs ($\gamma(e^-e^+)$) forming basic $z^0$ -preons of ~34 $m_e$ representing the CGT's prediction for the subsequent discovered boson X17, which generate preonic bosons $z_2(4z^0)$ and $z_\pi(7z^0)$ and constituent quarks in a preonic model, from two equations, one for the preonic quarks (u, d, s) and another for the heavy quarks (c-charm and b-bottom), a single unitary equation is obtained for the both mass variants: CGT/Souza and Standard Model, by using four parameters representing integer numbers from 0 to 3: $(k_1 ; k_2) \leq 3$ (for the number of $z_2$- and $z_\pi$-preonic bosons); f = (1; 2)- flavor number; n = (1÷4) –compositeness number, and a multiplication factor depending on n, n=4 giving a predicted quark, of mass ~15 GeV/$c^2$.
The values of constituent quarks masses in the S.M.'s variant result by the CGT's unitary formula with discrepancy under 1%, excepting the case of the u/d-quarks, ($M_{u/d}$ = 312; 313 GeV/$c^2$ –in CGT).

The fact that the gammonic/preonic clusters released by excited quarks during some de-excitation reactions are identifiable as hard gamma-quanta is in concordance with the known reaction: $\pi + p \rightarrow \gamma + n + Q_n$ , where the gamma ray, γ, has an energy of 129 MeV and the neutron's kinetic energy, $Q_n$, is 8.8 MeV, giving a total emitted energy of 137.8 MeV- close to the rest energy of the $\pi^-$ -pion, (139.57018 MeV).

Compared to the Standard Model's equation for the quarks' masses: m = f·υ, (υ ≈ 246 GeV- the vacuum expectation value; f- flavor parameter, which must be calculated) or to an equation with hiper-fine terms of Sacharov-type, it is observed that the Eq. (11), even if it is obtained semi-empirically, all the used constants: $M_{1,2}$, $z^0$, $z_2$, $z_\pi$, β, and parameters: $k_1$, $k_2$, n, f, are naturally explainable by the CGT's model of constituent quark.
-It results that also the mesons masses can be explained by the sum rule applied to the constituent masses of their quarks. Also, is no need the theory of Higgs bosons.

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