Exploration

The Possible Role of Newtonian, Strong & Electromagnetic Gravitational Constants in Particle Physics

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Abstract

Considering the earlier suggested gravitational coupling constants assumed to be associated with strong and electromagnetic interactions, we examine in this paper the applicability of the two microscopic gravitational constants in elementary particle physics. With further research and analysis, we are confident that currently believed quark theory can be refined and simplified.

\textbf{Keywords:} Quantum gravity, strong interaction, electromagnetic interaction, Gravitational Constant, Higgs boson, supersymmetry.

1. Introduction

Even though ‘String theory’ models and “quantum gravity” models [1-10] are having a strong mathematical background and sound physical basis, they are failing in implementing the Newtonian gravitational constant [11-16] in atomic, nuclear and particle physics and thus seem to fail in developing a ‘workable’ model of final unification. Considering this failure as a clear inadequacy of ‘current unification paradigm’, we established the existence of two microscopic gravitational coupling constants assumed to be associated with strong and electromagnetic interactions with applications starting from understanding atomic nuclei to neutron star mass and radius. By considering ‘integral charge supersymmetry’, we examine the applicability of the two microscopic gravitational constants in elementary particle physics in this paper.

1. 1 On Strong Gravity

According to W. Lerche [6], “the most dramatic extension of the Standard Model of particle physics that has been proposed so far is string theory. However, as we will discuss in more detail below, string theory too does not provide very concrete answers to the questions posed above. But what string theory does is to provide a resolution of conceptual problems that are on a far deeper level than these “practical” problems. One of the most important problems in modern theoretical physics is the apparent mutual incompatibility of quantum mechanics and general relativity (the theory of gravity) – one theory describing well the world at very short, the other at long distances. Certainly a truly satisfying unified theory should incorporate the gravitational

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interaction as well, even though traditionally it is not considered as belonging to particle physics”.

According to Juan M. Maldacena [7], “we now have a theory, called string theory (or M-theory), which has been able already to provide a solution to the first two challenges. Unfortunately, we do not know yet how to solve the third challenge. Maybe string theory is the solution and we just have to understand it better or maybe we have to modify it in some way. String theory is a theory under construction. We know several limits and aspects of the theory, but we still do not know the fundamental axioms of the theory that would enable us to approach the third challenge” (To Explain the Big Bang and the parameters of the Standard Model).

According to Roberto Onofrio [4], weak interactions are peculiar manifestations of quantum gravity at the Fermi scale, and that the Fermi coupling constant is related to the Newtonian constant of gravitation. In his opinion, at atto-meter scale, Newtonian [17-33] one can see number of papers on ‘strong gravity’. It may be noted that, till date, ‘strong gravity’ is a non-mainstream theoretical approach to Color confinement/particle confinement having both a cosmological scale and a particle scale gravity. In between ~(1960 to 2000), it was taken up as an alternative to the then young QCD theory by several theorists, including Abdus Salam [17]. Very interesting point to be noted is that, Abdus Salam showed that the ‘particle level gravity approach’ can produce confinement and asymptotic freedom while not requiring a force behavior differing from an inverse-square law, as does QCD.


In this paper, we try to combine the old ‘strong gravity’ concept with ‘Newtonian gravity’ along with integral charge supersymmetry and finally make an attempt to understand the constructional features elementary particles.

In pursuit of bridging the gap between general theory of relativity and quantum field theory in the earlier publications [34-50], we suggested and validated the role of two gravitational constants associated with strong and electromagnetic interactions and also suggested a supersymmetric fermion-boson mass ratio of 2.26.

**1.2 Possible False Failure of Supersymmetry**

Supersymmetry [51-56] differs notably from currently known symmetries in that its corresponding conserved charge (via Noether’s theorem) is a fermion called a super charge and carrying spin-1/2, as opposed to a scalar (spin-0) or vector (spin-1). A supersymmetry may also be interpreted as new fermionic (anti-commuting) dimensions of space-time, super-partners of the usual bosonic space-time coordinates, and, in this formulation, the theory is said to live in
super-space. Currently, there is only indirect evidence for the existence of supersymmetry, primarily in the form of evidence for gauge coupling unification. A central motivation for supersymmetry close to the TeV energy scale is the resolution of the hierarchy problem of the Standard Model. Without the extra supersymmetric particles, the Higgs boson mass is subject to quantum corrections which are so large as to naturally drive it close to the Planck mass barring its fine tuning to an extraordinarily tiny value. In supersymmetric theory, on the other hand, these quantum corrections are canceled by those from the corresponding super-partners above the supersymmetry breaking scale, which becomes the new characteristic natural scale for the Higgs mass.

Other attractive features of TeV-scale supersymmetry are the fact that it often provides a candidate dark matter particle at a mass scale consistent with thermal relic abundance calculations, provides a natural mechanism for electroweak symmetry breaking and allows for the precise high-energy unification of the weak, the strong and electromagnetic interactions. Therefore, scenarios where supersymmetric partners appear with masses not much greater than 1 TeV are considered the well-motivated by theorists. These scenarios would imply that experimental traces of the superpartners should begin to emerge in high-energy collisions at the LHC relatively soon. The Large Hadron Collider at CERN is currently producing the world’s highest energy collisions and offers the best chance at discovering super-particles for the foreseeable future.

In a conventional and currently believed modern approach, as of February 2016, no meaningful signs of the super-partners have been observed in LHC. The failure (false failure, in our opinion) of the Large Hadron Collider to find evidence for supersymmetry has led some physicists to suggest that the theory should be abandoned or modified. In this context, we would like to stress the idea that, if one is willing to modify the basic concepts of SUSY, certainly one can recognize and appreciate the great success of LHC already it had in producing super-partners. That is, “confirmation of the success of LHC” depends on how we perceive, how we analyze and how we interpret the data produced by LHC and problem is not with LHC.In “Supersymmetry in strong and weak interactions” [34], we extended the scope of supersymmetry to quarks and electroweak interaction. In this paper, we further simplified the procedure and succeededin establishing ‘integral charge quark supersymmetry’. It may also be noted that, we could publish our new concepts on ‘integral charge quark supersymmetry’in2011 DAE-BRNS conference proceedings [35].

1.3 Integral Charge Quark Supersymmetry

Until today there is no reason for the question: why there exist 6 individual quarks? Until today no experiment reported a ‘free quark with fractional charge’. In addition, recently discovered tetra and penta quarks demand changes in basic quark model. Our humble opinion is that nuclear charge (either positive or negative) constitutes 6 different flavors and each flavor holds certain mass. ‘Charged flavor’ can be called as a ‘quark’. It is neither a fermion nor a boson. A ‘fermion’ is a container for different charges, a ‘charge’ is a container for different flavors and each ‘flavor’ is a container for certain ‘matter’. If charged matter rests in a ‘fermionic container’
itis a fermion and if charged matter rests in a ‘bosonic container’ it is a boson. The fundamental questions to be answered are: What is a charge? Why and how opposite charges attracts each other? Why and how there exists a fermion container? Why and how there exists a boson container?

Here interesting thing is that if 6 flavors exist with 6 different masses, then a single charge can have one or two or more flavors simultaneously. Since charge is a common property, mass of the ‘multiple flavor charge’ seems to be the harmonic mean of the mass of each flavor. If ‘charge with flavor’ is called as a ‘quark’ then ‘charge with multi flavors’ can be called as a ‘hybrid quark’. Hybrid quark generates a multi flavor baryon. It is a property of ‘strong interaction space-time’. This is just like ‘different tastes’ or ‘different smells’ of matter. Important consequences of this idea are:

1) For each and every quark fermion, there exists a corresponding supersymmetric quark boson.
2) Quark fermion transforms into heavy quark baryon.
3) Quark boson transforms into heavy quark meson.
4) For generating a baryon there is no need to couple 3 fractional charge quarks.
5) For generating a boson there is no need to couple two fractional charge quark fermions.
6) There is no need to consider about ‘tetra’ and ‘penta’ quark combinations.

Due to strong interaction there is a chance of coupling any two quark bosons. If any two oppositely charged quark bosons couples together then a neutral quark boson can be generated. It may be called as a neutral meson. Due to strong interaction by any chance if any quark boson couples with any quark fermion then a neutral baryon or baryon with ±2e can be generated. This idea is very similar to the ‘photon absorption’ by electron. When a weakly interacting electron is able to absorb a photon, in strong interaction it is certainly possible. More over if a baryon couples with two or three quark bosons then the baryon mass increases and charge also changes. Here also if the system follows the principle – unlike charges attracts each other – in most of the cases baryon charge changes from ±e to neutral and neutral to ±e. In rare cases baryon with ±2e can be generated.

2. Three Basic Assumptions of Final Unification

In our earlier publications [34-50] we proposed and established the following three assumptions. In the references [34 to 50], one can find many applications starting from atomic nucleus to neutron star covering a wide range of physical phenomena including atomic radii and molar mass constant.

Assumption 1: Magnitude of the gravitational constant associated with the electromagnetic interaction is \[ G_e \approx (2.375 \pm 0.002) \times 10^{-67} \text{ m}^3 \text{kg}^{-1} \text{sec}^{-2}. \]

Assumption 2: Magnitude of the gravitational constant associated with the strong interaction is \[ G_s \approx (3.328 \pm 0.002) \times 10^{-28} \text{ m}^3 \text{kg}^{-1} \text{sec}^{-2}. \]
**Assumption 3:** Fermion-boson mass ratio is approximately $\Psi \simeq 2.255$. This idea can be applied to weakly interacting particles as well as strongly interacting particles.

Note 1: We choose the following semi-empirical relations as ‘reference relations’ for constructing other semi-empirical relations.

\[
\frac{m_p}{m_e} \approx \left( \frac{G_s m_p^2}{\hbar c} \right) \left( \frac{G_s m_p^2}{\hbar c} \right) \quad \text{and} \quad \left( \frac{G_s m_p m_e}{\hbar c} \right) \approx \left( \frac{\hbar c}{G_s m_e^2} \right) \quad (1)
\]

\[
m_p \approx \left( \frac{G_N}{G_e} \right)^{\frac{1}{6}} \left( \frac{\hbar c m_e^2}{G_N} \right)^{\frac{1}{6}} \sqrt{M_{pl} m_e} \quad (2)
\]

where $M_{pl} \approx \sqrt{\hbar c/G_N}$ is the Planck mass.

\[
\left( \frac{G_s m_p^2}{G_s m_p^2} \right) \approx 1 + \ln \left( \frac{m_p}{m_e} \right)^{2.5} \quad (3)
\]

Note 2: It may be noted that, with reference to the operating force magnitudes, protons and electrons cannot be considered as ‘black holes’. But protons and electrons can be assumed to follow the relations that black holes generally believed to follow. That is, in the study of black holes, Newtonian gravitational constant $G_N$ plays a major role, whereas in the study of elementary particles, $G_s$ and $G_e$ play the key role. For detailed information, see the following section.

### 3. Understanding the Planck’s Constant

Proceeding further, it is possible to show that

\[
h \equiv \sqrt{\frac{m_p}{m_e}} \left( \frac{G_s m_p^2}{4\pi\epsilon_0 c} \right) \quad (4)
\]

\[
h c \equiv \sqrt{\frac{m_p}{m_e}} \left( \frac{G_s m_p^2}{4\pi\epsilon_0} \right) \quad (5)
\]

Note that, these two relations are free from arbitrary coefficients. This is a very strange relation and seems to be connected with quantum theory of radiation. With further research, if one is able to derive these two relations, unification of quantum theory and gravity can be made practical and successful. Based on relation (5) and by considering the recommended values of elementary physical constants [57, 58]
\[
G_e \equiv \frac{4\pi\varepsilon_0 h c^2 m_e}{e^2 m_p} \approx 3.329560807 \times 10^{28} \text{ m}^3\text{kg}^{-1}\text{sec}^{-2}
\]
\[
G_e \equiv \frac{\hbar c^2}{G m_p m_e} \approx \left( \frac{\hbar}{c} \right)^2 \left( \frac{e^2 m_p}{4\pi\varepsilon_0 m_e} \right) \approx \left( \frac{e^2 m_p}{16\pi^2 \varepsilon_0 m_e} \right) \approx 2.374335471 \times 10^{37} \text{ m}^3\text{kg}^{-1}\text{sec}^{-2}
\]
\[
G_N \equiv \left( \frac{m_e}{m_p} \right)^{12} \left( \frac{G e^2 m_p}{\hbar c} \right) \approx \left( \frac{e^2 m_p}{\hbar c} \right)^{14} \left( \frac{4\pi\varepsilon_0}{e^2} \right)^2 \left( \frac{2\pi \hbar c^3}{m_p} \right) \approx 6.679856051 \times 10^{11} \text{ m}^3\text{kg}^{-1}\text{sec}^{-2}
\]

From this data it is very clear to say that, accuracy of \(G_N\) seems to depend only on the ratio of \((h/c)\). It is a very important point to be noted here. In the foregoing sections we adopt these unified values.

### 4. Key Points Pertaining to Final Unification

1) If it is true that \(c\) and \(G_N\) are fundamental physical constants, then \((c^4/G_N)\) can be considered as a fundamental compound constant related to a characteristic limiting force [59-62].

2) Black holes are the ultimate state of matter’s geometric structure.

3) Magnitude of the operating force at the black hole surface is of the order of \((c^4/G_N)\).

4) Gravitational interaction taking place at black holes can be called as ‘Schwarzschild interaction’.

5) Strength of ‘Schwarzschild interaction’ can be assumed to be unity.

6) Strength of any other interaction can be defined as the ratio of operating force magnitude and the classical or astrophysical force magnitude \((c^4/G_N)\).

7) If one is willing to represent the magnitude of the operating force as a fraction of \((c^4/G_N)\) i.e. \(X\) times of \((c^4/G_N)\), where \(X \ll 1\), then

\[
\frac{X \text{ times of } (c^4/G_N)}{(c^4/G_N)} \equiv X \rightarrow \text{Effective } G \Rightarrow G_N \frac{1}{X}
\]

If \(X\) is very small, \(\frac{1}{X}\) becomes very large. In this way, \(X\) can be called as the strength of interaction. Clearly speaking, strength of any interaction is \(\frac{1}{X}\) times less than the ‘Schwarzschild interaction’ and effective \(G\) becomes \(G \frac{1}{X}\).

8) With reference to Schwarzschild interaction, for electromagnetic interaction, \(X \approx 2.811 \times 10^{-8}\) and for strong interaction, \(X \approx 2.0 \times 10^{-9}\).
9) Characteristic operating force corresponding to electromagnetic interaction is \( (c^4/G_e) \approx 3.4 \times 10^{-4} \text{ N} \) and characteristic operating force corresponding to strong interaction is \( (c^4/G_s) \approx 242600 \text{ N} \).

10) Characteristic operating power corresponding to electromagnetic interaction is \( (c^5/G_e) \approx 10990 \text{ J/sec} \) and characteristic operating power corresponding to strong interaction is \( (c^5/G_s) \approx 7.27 \times 10^{13} \text{ J/sec} \).

11) Based on these concepts, it is possible to assume that,

\[
\frac{(m_e c^2)^3 (m_p c^2)^{1/2}}{\sqrt{(c^4/G_e)(c^4/G_s)}} \approx \hbar c \tag{8}
\]

\[
\frac{(m_e c^2)^{3/2} (m_p c^2)^{1/2}}{\sqrt{(c^5/G_e)(c^5/G_s)}} \approx \hbar \tag{9}
\]

12) As \( [(c^4/G_e), (c^4/G_s)] \ll (c^4/G_N) \) and \( [(c^5/G_e), (c^5/G_s)] \ll (c^5/G_N) \), protons and electrons cannot be considered as ‘black holes’, but may be assumed to follow similar relations that black holes generally believed to follow.

13) According to S.W. Hawking [63], temperature of black hole takes the following expression.

\[
T_B \approx \frac{\hbar c^3}{8\pi G_N k_B M_B} \tag{10}
\]

where \( M_B \) and \( T_B \) represent the mass and temperature of a black hole respectively.

According to Abhas Mithra [64,65], currently believed ‘black holes’ area kind of “Eternally Collapsing Objects”. The so-called massive Black Hole Candidates (BHCs) must be quasi-black holes rather than exact black holes and during preceding gravitational collapse, entire mass energy and angular momentum of the collapsing objects must be radiated away before formation of exact mathematical black holes. Abhas Mittra’s peer reviewed papers describe why continued physical gravitational collapse should lead to formation of ECOs rather than true black holes, and the mathematical “black hole” states can be achieved only asymptotically. An ECO is essentially a quasi-stable ultra-compact ball of fire (plasma) which is so hot due to preceding gravitational contraction that its outward radiation pressure balances its inward pull of gravity. Some astrophysicists claimed to have verified this prediction that astrophysical Black Hole Candidates are actually ECOs rather than true mathematical black holes. One can find relevant information at http://www.cv.nrao.edu/tuna/past/2006/NEW_QSO_STRUCTURE_FOUND.pdf. By considering these two views and by considering the proposed views, melting temperature of elementary particles can be estimated very easily.

From above concepts and relations, melting points of proton and electron can be estimated with the following relations. Melting point of proton,
This relation can be applied to quarks also. It may be noted that, RHIC have tentatively claimed to have created a quark–gluon plasma with an approximate temperature of 4 trillion degree Kelvin. A new record breaking temperature was set by ALICE at CERN on August, 2012 in the ranges of 5.5 trillion degree Kelvin. In June 2015, an international team of physicists have produced quark-gluon plasma at the Large Hadron Collider by colliding protons with lead nuclei at high energy inside the supercollider’s Compact Muon Solenoid detector at a temperature of 4 trillion degree Kelvin [66-69]. These experimental temperatures are close to the predicted melting temperatures of Proton, up, down and strange quarks and seem to support the proposed pseudo gravitational constant assumed to be associated with strong interaction.

Melting point of electron,

\[
T_{\text{electron}} \approx \frac{\hbar c^3}{8\pi k_B G_s m_e} \approx 0.3786 \text{ Million K}
\]  

Melting point of electron is \((1/38827)\) times the melting point of proton. These two estimations are for experimental verification. (Note that, a mistake happened in calculation at relation (32) of our recent publication[50]).

5. Role of the Newtonian Gravitational Constant in Particle Physics

A) Understanding Proton Rest Mass

After so many semi empirical relations, we noticed that,

\[
\sqrt{\frac{M_p m_e}{m_p}} \approx \left( \frac{G_e}{G_N} \right)^{1/6}
\]

where, \(M_p \approx \frac{\hbar c}{G_N}\). This observation needs experts hands-on experience in decoding its meaning at fundamental level. Based on this relation, if \(m_{npl} \approx \frac{\hbar c}{\sqrt{G_s}} \approx 546.6205673 \text{ MeV/c}^2 \approx \text{Nuclear Planck mass}\), it is possible to show that,
\[
m_p \approx \left( \frac{G_N}{G_e} \right)^{\frac{1}{6}} \sqrt{M_p m_e} \approx \left( \frac{m_e^6 M_{pl}}{m_{mpl}^2} \right)^{\frac{1}{3}}
\]

\[
\left[ \frac{G_N^2 m_e^2}{G_N h c} \right]^{\frac{1}{10}} \approx \left[ \left( \frac{G_s}{G_N} \right) \left( \frac{m_{pl}^2}{m_{mpl}^2} \right) \right]^{\frac{1}{10}}
\]

(14)

B) Fitting & Understand Muon & Tau Rest Masses

It may be noted that, \( \left( \frac{G_e}{G_N} \right)^{\frac{1}{3}} \approx \left( \frac{\sqrt{M_p m_e}}{m_p} \right)^{\frac{3}{2}} \) seems to play a crucial role in fitting muon and tau rest masses in the following way.

\[
\left[ \gamma^3 + \left( n^2 \gamma \right)^a \left( \frac{G_e}{G_N} \right)^2 \sqrt{\frac{e^2 c^4}{4 \pi \epsilon_0 G_e}} \right] \left[ \gamma^3 + \left( n^2 \gamma \right)^a \left( \frac{G_e}{G_N} \right)^2 \right]^{\frac{1}{3}} \approx 0.00175 \text{ MeV}
\]

(15)

\[
\gamma \approx \sqrt{\frac{4 \pi \epsilon_0 G_e m_e^2}{e^2}} \approx 292.2328 \text{ and } n \approx 1.2. \text{ Obtained masses of muon and tau are } 106.54 \text{ MeV and 1781.54 MeV and can be compared with the respective experimental values of 105.66 MeV and 1776.86 MeV [57].}
\]

C) Fitting & Understanding the Characteristic Charged Lepton

It may be noted that, recent galactic X-ray [70-74] studies strongly confirm the existence of a new photon of energy 3.5 keV. Its origin is unknown and scientists guess that, it is a decay product of 7 keV sterile neutrino. In this context, we would like to suggest the following alternative mechanism for understanding the origin of 3.5 keV the photon.

1) There exists a charged lepton of rest mass,

\[
(m_\alpha)^4 \approx \sqrt{\frac{e^2}{4 \pi \epsilon_0 G_e}} \approx 1.75 \text{ keV/c}^2
\]

(16)

2) \( (m_\alpha) \approx 1.75 \text{ keV/c}^2 \) plays a vital role in generating the observed charged leptons.

3) With pair annihilation mechanism, \( (m_\alpha) \) generates a photon of rest energy 3.5 keV

4) With current and future particle accelerators \( (m_\alpha)^4 \approx 1.75 \text{ keV/c}^2 \) can be generated.
D) Fitting the weak coupling angle

Weak coupling angle can be defined as follows [57].

$$\sin \theta_W \approx \sqrt{\frac{4\pi\varepsilon_0 G_s m_p m_e}{e^2}} \approx 0.4689276$$  \hspace{1cm} (17)$$

$$\sin^2 \theta_W \approx \left(\frac{4\pi\varepsilon_0 G_s m_p m_e}{e^2}\right)$$  \hspace{1cm} (18)$$

E) Understanding the strong coupling constant

We define the strong coupling constant as follows.

$$\frac{1}{\alpha_s} \approx \exp \sqrt{\frac{e^2}{4\pi\varepsilon_0 G_s m_p m_e}} \approx 8.436146$$

$$\rightarrow \alpha_s \approx \left\{ \exp \sqrt{\frac{e^2}{4\pi\varepsilon_0 G_s m_p m_e}} \right\}^{-1} \approx 0.11853754$$  \hspace{1cm} (19)$$

F) Relation between weak coupling angle and strong coupling constant

$$\sin \theta_W \approx \left[ \ln \left( \frac{1}{\alpha_s} \right) \right]^{-1} \approx 0.4689276$$  \hspace{1cm} (20)$$

$$\sin^2 \theta_W \approx \left[ \ln \left( \frac{1}{\alpha_s} \right) \right]^{-2} \approx 0.21989305$$  \hspace{1cm} (21)$$

G) Understanding the weakly interacting boson

We define that

$$\frac{m_{X_f} c^2}{m_{pf} c^2} \approx \frac{m_{X_b} c^2}{m_{pb} c^2} \approx \ln \left( \frac{G_e}{G_N} \right) \approx 109.5$$  \hspace{1cm} (22)$$

where $m_{X_f}$ is the assumed mass of characteristic weakly interacting fermion and $m_{pf}$ is the rest mass of proton.

$m_{X_b}$ is the assumed mass of characteristic weakly interacting boson and $m_{pb}$ is the rest mass of proton in bosonic form.

Thus, in fermionic form,
\( m_{Xf}c^2 \approx \ln \left( \frac{G}{G_N} \right) m_{\gamma f}c^2 \)
\[ (23) \]
\[ \approx 109.4897 \times 938.272 \text{ MeV} \approx 102731.12 \approx 102731.0 \text{ MeV} \]

With reference to Supersymmetry and Higgs physics, this characteristic charged fermion can be called as the ‘charged SUSY Higgs fermion’. With reference to electroweak theory [57], we noticed that,

\[ m_{Xf}c^2 \approx \frac{248.04 \text{ GeV}}{\sin \theta_W \cos \theta_W} \approx 246.22 \text{ GeV} \]
\[ (24) \]

In bosonic form,

\[ m_{Xb}c^2 \approx \ln \left( \frac{G}{G_N} \right) \left( \frac{m_{\gamma f}c^2}{\Psi} \right) \]
\[ (25) \]
\[ \approx 109.4897 \times \left( \frac{938.272}{2.255} \right) \text{ MeV} \]
\[ \approx 109.5 \times (416.085) \text{ MeV} \approx 45557.04 \text{ MeV} \approx 45557.0 \text{ MeV} \]

With reference to Supersymmetry and Higgs physics, this characteristic charged boson can be called as the ‘charged Higgs SUSY boson’.

Note 3: These two proposed mass units play a key role in estimating the quark baryon and quark meson rest masses. In our earlier publication, we proposed two susy mass units as 11450 MeV and 5060 MeV. In this paper, with reference to electroweak interaction and Higgs concept of mass generation, considering \( \left( \frac{\sin \theta_W}{2} \right) \) as a proportionality ratio, we try to modify them as 102731 MeV and 45557 MeV respectively.

Note 4: Very interesting and exciting observation is that, quark mesonic mass of 45557 MeV is 10681 MeV and can be compared with recently discovered charged meson [75].

**H) Understanding the weakly interacting neutral Z boson**

It can be interpreted as the mass summation of positive \( m_{Xb}c^2 \) and negative \( m_{Xb}c^2 \).

\[ m_Zc^2 \approx (m_{Xb}c^2)^+ + (m_{Xb}c^2)^- \]
\[ (26) \]
\[ \approx 2 \times 45557 \text{ MeV} \approx 91114 \text{ MeV} \]

**I) Understanding the weakly interacting charged W boson**

From electro weak theory [57],

\[ \sin \theta_W \cos \theta_W \]

\[ \sin \theta_W \cos \theta_W \]

\[ \sin \theta_W \cos \theta_W \]
\[ m_W c^2 \approx \cos \theta_W m_Z c^2 \approx 80475.22 \text{ MeV} \approx 80475.0 \text{ MeV} \]
where \( \cos \theta_W \approx 0.8832366 \)  

(27)

**J) Understanding the newly discovered Higgs boson of rest energy 126 GeV**

It is noticed that [57],

\[ m_H c^2 \approx \left( m_{Xb} c^2 \right)^\pm + \left( m_W c^2 \right)^\mp \approx 45557.0 + 80475.0 \approx 126032.0 \text{ MeV} \]

(28)

6. **Understanding Baryon & Meson Mass Spectrum**

This proposed model differs from current model of quark theory in many ways. See the following table. Important points to be noted are:

A) There exist integral charge quark fermions and integral charge quark bosons.

B) Integral charge quark fermions transform into integral charge quark baryons.

C) Integral charge quark bosons transform into integral charge quark mesons.

D) All the observed baryons including the currently believed exotic penta quarks [76] of charge \( \pm e \) can be understood as two flavor quark baryons having charge \( \pm e \).

E) Observed baryonic doublets and triplets can be understood as combinations of two flavor quark baryons coupled with light quark bosons like \( u_b = 1.91 \text{ MeV/} c^2 \), \( d_b = 4.1 \text{ MeV/} c^2 \) and \( s_b = 66.5 \text{ MeV/} c^2 \).

F) Ground and excited quark mesons couple with light quark bosons like \( u_b = 1.91 \text{ MeV/} c^2 \), \( d_b = 4.1 \text{ MeV/} c^2 \) and \( s_b = 66.5 \text{ MeV/} c^2 \) generating ground and excited light neutral mesons.

G) Ground or exited quark mesons couple with other quark mesons generating heavy neutral mesons. With this idea recently discovered heavy tetra quark mesons[77-80] can be understood very easily.

H) Currently believed neutral pion constitutes a pair of strange bosons generating a mass of \( 2s_b = 133.0 \text{ MeV/} c^2 \).

I) Currently believed charged pion can be considered as a combination of neutral pion and one \( d_b = 4.1 \text{ MeV/} c^2 \) generating a mass of \( 137.0 \text{ MeV/} c^2 \).

J) Excited charged baryons and charged mesons can be shown to be following a relation of \( n^{1/4} \) where \( n = 1, 2, 3, \ldots \)

K) Currently believed charged W boson is very close to the top quark boson. It is for further research and discussion.

L) Currently believed bottom and anti-bottom mesons can be considered as the combination of second generation bottom and anti-bottom mesons only.

M) Currently believed tetra quark charged mesons can be considered as the second generation bottom-strange mesons.
### Table 1. Comparative study on standard quark model and modified integral charge SUSY quark model

<table>
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<tr>
<th>S.No</th>
<th>Standard quark model</th>
<th>Proposed model</th>
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<tbody>
<tr>
<td>1</td>
<td>There exist only 6 quarks supposed to have fermionic behavior with fractional charge</td>
<td>There exist 6 quark fermions as well as 6 quark bosons having charge ( \pm e ).</td>
</tr>
<tr>
<td>2</td>
<td>A. Priority is given to ‘fractional charges’. B. Particle selection is based on ‘fractional charge’</td>
<td>A. Priority is given to integral charge B. ‘Combination of quark flavors’ play a key role rather than ‘physical coupling of quark fermions’</td>
</tr>
<tr>
<td>3</td>
<td>Three quarks couple together to form any observable baryon</td>
<td>Physically there exists only one massive quark (quark baryon) with 2 quark flavors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. By any reason, any two quark baryons couple together, energy can be generated by charge annihilation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Light quark boson couples with quark baryons and generates doublets and triplets. This is similar to ‘absorption of electrons by atom’.</td>
</tr>
<tr>
<td>4</td>
<td>Two quarks couple together to form any observable meson</td>
<td>Physically there exists only one heavy quark boson (quark meson) with two or three quark flavors.</td>
</tr>
<tr>
<td>5</td>
<td>Understanding and predicting the masses of penta quarks and tetra quarks is very complicated</td>
<td>Understanding and predicting the masses heavy baryons and heavy mesons is very easy.</td>
</tr>
<tr>
<td>6</td>
<td>No clear cut explanation is available for understanding the heaviness of proton mass compared to the sum of two up and one down quark rest masses</td>
<td>Proton rest mass can be fitted and understood with the harmonic mean of up quark baryon rest mass and down quark baryon rest mass.</td>
</tr>
<tr>
<td>7</td>
<td>Complicated mass relations</td>
<td>Up, strange and bottom quarks are in one geometric series and Down, charm and top quarks are in another geometric series</td>
</tr>
<tr>
<td>8</td>
<td>Classification scheme is based on particle charge, particle mass and particle decay scheme.</td>
<td>Classification scheme is based on particle charge, particle mass and quark flavors</td>
</tr>
<tr>
<td>9</td>
<td>No definition is available for weak coupling angle (( \sin \theta_W )) in terms of quark masses</td>
<td>Ratio of up quark mass and down quark mass can be considered as the magnitude of the weak coupling angle (( \sin \theta_W )).</td>
</tr>
<tr>
<td>10</td>
<td>No relation is available between strong coupling constant and up and down quark masses</td>
<td>1. Down and up quark mass ratio can be considered as the natural logarithm of inverse of the strong coupling constant. 2. Ratio of electron rest mass and up quark rest mass can be considered as</td>
</tr>
</tbody>
</table>
7. Estimating the Quark Mass

A) Estimate the masses of up and down quarks

We define that,

\[
\frac{d_f c^2}{u_f c^2} \approx \frac{d_b c^2}{u_b c^2} \approx \ln \left( \frac{1}{\alpha_s} \right) \approx \sqrt{\frac{e^2}{4\pi\alpha_0 G_s m_p m_e}} \approx 2.132526 \approx K \ldots (say) \tag{29}
\]

\(d_f\) is the assumed rest mass of down quark fermion and \(u_f\) is the assumed rest mass of up quark fermion.

\(d_b \approx (d_f / \Psi)\) is the assumed rest mass of down quark boson and \(u_b \approx (u_f / \Psi)\) is the assumed rest mass of up quark boson. Clearly speaking,

\[
\frac{\text{Down quark fermion mass}}{\text{Up quark fermion mass}} \approx \frac{\text{Down quark boson mass}}{\text{Up quark boson mass}} \approx \ln \left( \frac{1}{\alpha_s} \right) \tag{30}
\]

\[
\frac{u_f c^2}{m_{ef} c^2} \approx \left( \frac{1}{\alpha_s} \right) \approx \exp \sqrt{\frac{e^2}{4\pi\alpha_0 G_s m_p m_e}} \tag{31}
\]

where \(m_{ef}\) is the rest mass of electron in fermion form and \(m_{eb} \approx (m_{ef} / \Psi)\) is the rest mass of electron in bosonic form. Clearly speaking,
Seshavatharam, U. V. S. & Lakshminarayana, S., The Possible Role of Newtonian, Strong & Electromagnetic Gravitational Constants in Particle Physics

\[ \text{Up quark fermion mass } \equiv \left( \frac{1}{\alpha_s} \right) \exp \left( \frac{e^2}{4\pi e_0 G_s m_p m_e} \right) \quad (32) \]

\[ u_f c^2 \equiv \left( \frac{1}{\alpha_s} \right) m_{u_f} c^2 \equiv K m_{u_f} c^2 \approx 4.31 \text{ MeV} \quad (33) \]

\[ u_b c^2 \equiv \left( \frac{1}{\alpha_s} \right) \left( \frac{m_{u_f} c^2}{\Psi} \right) \approx K \left( m_{u_b} c^2 \right) \approx 1.91 \text{ MeV} \quad (34) \]

\[ d_f c^2 \equiv \ln \left( \frac{1}{\alpha_s} \right) u_f c^2 \equiv \ln(K) (u_f c^2) \approx 9.20 \text{ MeV} \]

\[ d_b c^2 \equiv \ln \left( \frac{1}{\alpha_s} \right) u_b c^2 \equiv \ln(K) (u_b c^2) \approx 4.08 \text{ MeV} \quad (35) \]

It may be noted that, proposed up and down quark fermion rest masses are roughly two times the recommended values \[34,57\].

B) Fitting & Understanding the mass difference of neutron and proton

Neutron-proton mass difference can be fitted with the following relation.

\[ (m_n - m_p) c^2 \equiv \left( \frac{u_f}{d_f} \right)^2 \left[ \frac{2u_f d_f}{(u_f + d_f)} \right] \approx 1.291 \text{ MeV} \]

\[ \approx 0.494 \left[ \frac{2u_b d_b}{(u_b + d_b)} \right] \approx \frac{1}{2} \left[ \frac{2u_b d_b}{(u_b + d_b)} \right] \quad (36) \]

C) Estimating the masses of strange and bottom quarks

We define that, up, strange and bottom quarks are geometric series and their geometric ratio can be expressed in the following form.

\[ g_{ub} \approx \left( K \left( \frac{K + 1}{K - 1} \right) \right)^2 \approx 34.79 \quad (37) \]

Thus, in fermionic form, strange and bottom quark fermion masses can be estimated in the following way.
In bosonic form, strange and bottom quark boson masses can be estimated in the following way
\[ s_b c^2 \approx 34.79 \times 4.31 \text{ MeV} \approx 149.95 \approx 150.0 \text{ MeV} \]
\[ b_b c^2 \approx (34.79)^2 \times 4.31 \text{ MeV} \approx 5217.2 \approx 5217.0 \text{ MeV} \] (38)

D) Estimate the masses of charm and top quarks

We define that, down, charm and top quarks are geometric series and their geometric ratio can be expressed in the following form.
\[ g_{det} \equiv \left( 2K \left( \frac{K+1}{K-1} \right) \right)^2 \approx 139.17 \] (40)

Thus, in fermionic form, charm and top quark fermion masses can be estimated in the following way
\[ c_f c^2 \approx 139.17 \times 9.20 \text{ MeV} \approx 1280.35 \approx 1280.0 \text{ MeV} \]
\[ t_f c^2 \approx (139.17)^2 \times 9.20 \text{ MeV} \approx 178185.05 \approx 178185.0 \text{ MeV} \] (41)

In bosonic form, charm and top quark boson masses can be estimated in the following way
\[ c_b c^2 \approx 139.15 \times 4.08 \text{ MeV} \approx 567.81 \approx 568.0 \text{ MeV} \]
\[ t_b c^2 \approx (139.17)^2 \times 4.08 \text{ MeV} \approx 79021.2 \approx 79021.0 \text{ MeV} \] (42)

\[ \frac{\text{Down quark series geometric ratio}}{\text{Up quark series geometric ratio}} \approx 4 \] (43)

8. Estimating the Masses of Quark Baryons

Quark baryonmass can be defined in the following way.
\[ Q_b c^2 \approx \frac{1}{2K} \left[ \left( m_{Xf} c^2 \right)^2 \left( m_{Qf} c^2 \right) \right]^{\frac{1}{3}} \]
\[ \approx \frac{\sin \theta_Y}{2} \left[ \left( m_{Xf} c^2 \right)^2 \left( m_{Qf} c^2 \right) \right]^{\frac{1}{3}} \] (44)
where, $Q_b$ is the quark baryon mass, $Q_f$ is the corresponding quark fermion mass and $m_Xf$ is the proposed characteristic weakly interacting fermion of rest energy $10 2731$ MeV. See the following table-2 for quark fermion and quark baryon rest energies.

Table 2. Quark baryon masses

<table>
<thead>
<tr>
<th>Quark</th>
<th>Quark fermion rest energy $m_{Qf}c^2$ MeV</th>
<th>Quark baryon rest energy $Q_b c^2$ MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>4.31</td>
<td>837.0</td>
</tr>
<tr>
<td>Down</td>
<td>9.20</td>
<td>1078.0</td>
</tr>
<tr>
<td>Strange</td>
<td>150.5</td>
<td>2736.0</td>
</tr>
<tr>
<td>Charm</td>
<td>1280.0</td>
<td>5584.0</td>
</tr>
<tr>
<td>Bottom</td>
<td>5217.0</td>
<td>8920.0</td>
</tr>
<tr>
<td>Top</td>
<td>178185.0</td>
<td>28940.0</td>
</tr>
</tbody>
</table>

9. Estimating the Masses of Quark Mesons

Quark meson mass can be defined in the following way.

$$Q_Mc^2 \approx \frac{1}{2K} \left[ \left( m_{Xb}c^2 \right)^2 \left( m_{Qb}c^2 \right) \right]^{\frac{1}{3}}$$

$$\approx \frac{\sin \theta_W}{2} \left[ \left( m_{Xb}c^2 \right)^2 \left( m_{Qb}c^2 \right) \right]^{\frac{1}{3}}$$

(45)

where, $Q_M$ is the quark meson mass, $Q_b$ is the corresponding quark boson mass and $m_Xb$ is the proposed characteristic weakly interacting boson of rest energy $45557$ MeV. See the following table-3 for quark boson and quark meson rest energies.

Table 3. Quark gluon masses

<table>
<thead>
<tr>
<th>Quark</th>
<th>Quark boson rest energy $m_{Qb}c^2$ MeV</th>
<th>Quark meson rest energy $Q_Mc^2$ MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>1.91</td>
<td>371.0</td>
</tr>
<tr>
<td>Down</td>
<td>4.08</td>
<td>478.0</td>
</tr>
<tr>
<td>Strange</td>
<td>66.5</td>
<td>1212.0</td>
</tr>
<tr>
<td>Charm</td>
<td>568.0</td>
<td>2477.0</td>
</tr>
<tr>
<td>Bottom</td>
<td>2312.0</td>
<td>3955.0</td>
</tr>
<tr>
<td>Top</td>
<td>79021.0</td>
<td>12834.0</td>
</tr>
</tbody>
</table>
10. Ground State Baryon Mass Spectrum

With reference to previous section, one may expect 15 ground state baryons in the following way.

1) ud ground state baryon having charge $\pm e$

$$ (ud)_B \approx \frac{2u_d d_B}{u_B + d_B} \approx 942.0 \text{ MeV}/c^2 $$

2) su ground state baryon having charge $\pm e$

$$ (su)_B \approx \frac{2s_u u_B}{s_B + u_B} \approx 1282.0 \text{ MeV}/c^2 $$

3) sd ground state baryon having charge $\pm e$

$$ (sd)_B \approx \frac{2s_d d_B}{s_B + d_B} \approx 1547.0 \text{ MeV}/c^2 $$

4) cu ground state baryon having charge $\pm e$

$$ (cu)_B \approx \frac{2c_u u_B}{c_B + u_B} \approx 1456.0 \text{ MeV}/c^2 $$

5) cd ground state baryon having charge $\pm e$

$$ (cd)_B \approx \frac{2c_d d_B}{c_B + d_B} \approx 1807.0 \text{ MeV}/c^2 $$

6) cs ground state baryon having charge $\pm e$

$$ (cs)_B \approx \frac{2c_s s_B}{c_B + s_B} \approx 3673.0 \text{ MeV}/c^2 $$

7) bu ground state baryon having charge $\pm e$

$$ (bu)_B \approx \frac{2b_u u_B}{b_B + u_B} \approx 1530.0 \text{ MeV}/c^2 $$

8) bd ground state baryon having charge $\pm e$

$$ (bd)_B \approx \frac{2b_d d_B}{b_B + d_B} \approx 1924.0 \text{ MeV}/c^2 $$

9) bs ground state baryon having charge $\pm e$

$$ (bs)_B \approx \frac{2b_s s_B}{b_B + s_B} \approx 4188.0 \text{ MeV}/c^2 $$
10) bc ground state baryon having charge $\pm e$

$$(bc)_B \approx \frac{2b_c c_B}{b_B + c_B} \approx 6868.0 \text{ MeV}/c^2$$

11) tu ground state baryon having charge $\pm e$

$$(tu)_B \approx \frac{2t_u u_B}{t_B + u_B} \approx 1627.0 \text{ MeV}/c^2$$

12) td ground state baryon having charge $\pm e$

$$(td)_B \approx \frac{2t_d d_B}{t_B + d_B} \approx 2079.0 \text{ MeV}/c^2$$

13) ts ground state baryon having charge $\pm e$

$$(ts)_B \approx \frac{2t_s s_B}{t_B + s_B} \approx 4999.0 \text{ MeV}/c^2$$

14) tc ground state baryon

$$(tc)_B \approx \frac{2t_c c_B}{t_B + c_B} \approx 9362 \text{ MeV}/c^2$$

15) tb ground state baryon having charge $\pm e$

$$(tb)_B \approx \frac{2t_b b_B}{t_B + b_B} \approx 13637 \text{ MeV}/c^2$$

10.1 Excited baryon mass spectrum

Excited charged baryon levels can be expressed in the following way.

$$\left( Baryon \right)_{\text{excited}} \approx \frac{1}{n^4} \left( Baryon \right)_{\text{ground}}$$

where, $n = 1, 2, 3, \ldots$

See table-4 for the charged baryon mass spectrum starting from (u,d) baryons to (bs) baryons. This proposal is almost similar to Regge trajectory of mesons or baryons. See the following table-4 for the excited quark baryon levels.
Considering the data presented in table 1, a variety of neutral baryons can be generated. In general, ground and excited state charged baryons seem to couple with light quark bosons like up boson of mass 1.9 MeV/c², down quark boson of mass 4.08 MeV/c² and strange quark boson of mass 66.5 MeV/c² and generates neutral as well as charged baryons. Considering the data presented in table-3 and table-1, a variety of neutral baryons can be generated. In general, ground and excited state charged baryons seem to couple with 1.91 MeV, 4.08 MeV and 66.5 MeV light quark bosons and generate neutral ground and excited state baryons.

For example,

A) \((ud)^{\pm e}_B\) baryons and \(\{\text{excited } (ud)^{\pm e}_B\} + (u_b, d_b, s_b)\) can be compared with Lambda, sigma and Xi baryons. See the following table 5. Data accuracy can be improved by considering proton mass as the ground state mass.

B) \((su)^{\pm e}_B\) baryons and \(\{\text{excited } (su)^{\pm e}_B\} + (u_b, d_b, s_b)\) can be compared with Omega baryons.

C) \((bu)^{\pm e}_B\) baryons and \(\{\text{excited } (bu)^{\pm e}_B\} + (u_b, d_b, s_b)\) can be compared with currently believed charmed baryons.
See the following table 5 for ground and excited Lambda, Delta, Sigma and Xi baryons.

**Table 5.** Ground and excited Lambda, Delta, Sigma and Xi baryons

<table>
<thead>
<tr>
<th>$n$</th>
<th>$\frac{1}{n^2}$</th>
<th>$(ud)^{\pm e}_B$ levels</th>
<th>$(ud)^{\pm e}_B$ levels</th>
<th>$(ud)^{\pm e}_B$ levels</th>
<th>$(ud)^{\pm e}_B$ levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>942</td>
<td>944</td>
<td>946</td>
<td>1009</td>
</tr>
<tr>
<td>2</td>
<td>1.1892071</td>
<td>1120.2331</td>
<td>1122</td>
<td>1124</td>
<td>1187</td>
</tr>
<tr>
<td>3</td>
<td>1.316074</td>
<td>1239.7417</td>
<td>1242</td>
<td>1244</td>
<td>1306</td>
</tr>
<tr>
<td>4</td>
<td>1.4142136</td>
<td>1332.1892</td>
<td>1334</td>
<td>1336</td>
<td>1399</td>
</tr>
<tr>
<td>5</td>
<td>1.4953488</td>
<td>1408.6186</td>
<td>1411</td>
<td>1413</td>
<td>1475</td>
</tr>
<tr>
<td>6</td>
<td>1.5650846</td>
<td>1474.3097</td>
<td>1476</td>
<td>1478</td>
<td>1541</td>
</tr>
<tr>
<td>7</td>
<td>1.6265766</td>
<td>1532.2352</td>
<td>1534</td>
<td>1536</td>
<td>1599</td>
</tr>
<tr>
<td>8</td>
<td>1.6817928</td>
<td>1584.2488</td>
<td>1586</td>
<td>1588</td>
<td>1651</td>
</tr>
<tr>
<td>9</td>
<td>1.7320508</td>
<td>1631.5919</td>
<td>1634</td>
<td>1636</td>
<td>1698</td>
</tr>
<tr>
<td>10</td>
<td>1.7782794</td>
<td>1675.1392</td>
<td>1677</td>
<td>1679</td>
<td>1742</td>
</tr>
<tr>
<td>11</td>
<td>1.8211603</td>
<td>1715.533</td>
<td>1717</td>
<td>1720</td>
<td>1782</td>
</tr>
<tr>
<td>12</td>
<td>1.8612097</td>
<td>1753.2595</td>
<td>1755</td>
<td>1757</td>
<td>1820</td>
</tr>
</tbody>
</table>

### 10.3 Fitting & Understanding Penta Quarks

It may be noted that, recently particle physicists guess about the existence of penta quarks. In this context, 1530 MeV, 4380 MeV and 4450 MeV believed to be penta quarks. 1530 MeV can be considered as the ground state level of $(ba)^{\pm e}_B$. Similarly, 4380 MeV can be considered as the 2nd excited level of $(cb)^{\pm e}_B$. With further analysis, back ground physics of currently believed penta quarks can be understood in a very simple and unified approach.

### 11. Understanding Meson Mass Spectrum

Point to be noted is that, all the observed medium and heavy mesons are composed of quark mesons only.

Various compound quark mesons having charge $e$ can be expressed in the following way.

1) ud meson having charge $\pm e$

$$ (ud)_M \approx \frac{2u_M d_M}{u_M + d_M} \approx 418.0 \text{ MeV}/c^2 $$

2) su meson having charge $\pm e$
Seshavatharam, U. V. S. & Lakshminarayana, S., *The Possible Role of Newtonian, Strong & Electromagnetic Gravitational Constants in Particle Physics*

\[
(su)_M = \frac{2s_M u_M}{s_M + u_M} \approx 568.0 \text{ MeV}/c^2
\]

3) sd meson having charge $\pm e$

\[
(sd)_M = \frac{2s_M d_M}{s_M + d_M} \approx 686.0 \text{ MeV}/c^2
\]

4) cu meson having charge $\pm e$

\[
(cu)_M = \frac{2c_M u_M}{c_M + u_M} \approx 645.0 \text{ MeV}/c^2
\]

5) cd meson having charge $\pm e$

\[
(cd)_M = \frac{2c_M d_M}{c_M + d_M} \approx 801.0 \text{ MeV}/c^2
\]

6) cs meson having charge $\pm e$

\[
(cs)_M = \frac{2c_M s_M}{c_M + s_M} \approx 1628.0 \text{ MeV}/c^2
\]

7) bu meson having charge $\pm e$

\[
(bu)_M = \frac{2b_M u_M}{b_M + u_M} \approx 678.0 \text{ MeV}/c^2
\]

8) bd meson having charge $\pm e$

\[
(bd)_M = \frac{2b_M d_M}{b_M + d_M} \approx 853.0 \text{ MeV}/c^2
\]

9) bs meson having charge $\pm e$

\[
(bs)_M = \frac{2b_M s_M}{b_M + s_M} \approx 1855.0 \text{ MeV}/c^2
\]

10) bc meson having charge $\pm e$

\[
(bc)_M = \frac{2b_M c_M}{b_M + c_M} \approx 3046.0 \text{ MeV}/c^2
\]

11) tu meson having charge $\pm e$

\[
(tu)_M = \frac{2t_M u_M}{t_M + u_M} \approx 721.0 \text{ MeV}/c^2
\]

12) td meson having charge $\pm e$

\[
(td)_M = \frac{2t_M d_M}{t_M + d_M} \approx 922.0 \text{ MeV}/c^2
\]
13) ts meson having charge \( \pm e \)

\[
(t_s)_M = \frac{2 t_M s_M}{t_M + s_M} \approx 2215.0 \text{ MeV/c}^2
\]

14) tc meson having charge \( \pm e \)

\[
(t_c)_M = \frac{2 t_M c_M}{t_M + c_M} \approx 4153.0 \text{ MeV/c}^2
\]

15) tb meson having charge \( \pm e \)

\[
(t_b)_M = \frac{2 t_M b_M}{t_M + b_M} \approx 6047.0 \text{ MeV/c}^2
\]

Any two mesons out of 6 basic quark mesons and 15 compound quark mesons generate the observed neutral mesons.

For example, see the following Table 6 for the estimated neutral up mesons to bottom mesons. In addition, currently believed tetra neutral tetra quark meson masses can also be fitted.

**Table 6.** Estimated neutral up mesons to bottom mesons

| \( d_M + u_M \approx 849.0 \text{ MeV} \) | \( c_M + (u)_M \approx 2848.0 \text{ MeV} \) | \( (bs)_M + (u)_M \approx 2226.0 \text{ MeV} \) |
| \( (ud)_M + u_M \approx 789.0 \text{ MeV} \) | \( c_M + (ud)_M \approx 2895.0 \text{ MeV} \) | \( (bs)_M + (ud)_M \approx 2273.0 \text{ MeV} \) |
| \( (ud)_M + d_M \approx 896.0 \text{ MeV} \) | \( c_M + (d)_M \approx 2955.0 \text{ MeV} \) | \( (bs)_M + (d)_M \approx 2333.0 \text{ MeV} \) |
| \( (su)_M + u_M \approx 939.0 \text{ MeV} \) | \( c_M + (su)_M \approx 3045.0 \text{ MeV} \) | \( (bs)_M + (su)_M \approx 2423.0 \text{ MeV} \) |
| \( (su)_M + d_M \approx 1046.0 \text{ MeV} \) | \( c_M + (sd)_M \approx 3163.0 \text{ MeV} \) | \( (bs)_M + (sd)_M \approx 2541.0 \text{ MeV} \) |
| \( (su)_M + (ud)_M \approx 986.0 \text{ MeV} \) | \( c_M + (cu)_M \approx 3122.0 \text{ MeV} \) | \( (bs)_M + (cu)_M \approx 2500.0 \text{ MeV} \) |
| \( (cu)_M + (u)_M \approx 1016.0 \text{ MeV} \) | \( c_M + (cd)_M \approx 3278.0 \text{ MeV} \) | \( (bs)_M + (cd)_M \approx 2656.0 \text{ MeV} \) |
| \( (cu)_M + (d)_M \approx 1123.0 \text{ MeV} \) | \( c_M + (s)_M \approx 3689.0 \text{ MeV} \) | \( (bs)_M + (s)_M \approx 3483.0 \text{ MeV} \) |
| \( (cu)_M + (ud)_M \approx 1063.0 \text{ MeV} \) | \( c_M + (cs)_M \approx 4105.0 \text{ MeV} \) | \( (bs)_M + (bs)_M \approx 2533.0 \text{ MeV} \) |
| \( s_M + (u)_M \approx 1583.0 \text{ MeV} \) | \( c_M + (bu)_M \approx 3155.0 \text{ MeV} \) | \( (bs)_M + (bd)_M \approx 2708.0 \text{ MeV} \) |
| \( s_M + (ud)_M \approx 1630.0 \text{ MeV} \) | \( c_M + (bs)_M \approx 4332.0 \text{ MeV} \) | \( (bs)_M + (bs)_M \approx 3710.0 \text{ MeV} \) |
| \( s_M + (d)_M \approx 1690.0 \text{ MeV} \) | \( c_M + c_M \approx 4954.0 \text{ MeV} \) |  |
| \( s_M + s_M \approx 2424.0 \text{ MeV} \) |  |  |
$(cs)_M + (cu)_M \approx 2273.0 \text{ MeV}$
$(cx)_M + (cd)_M \approx 2429.0 \text{ MeV}$
$(cs)_M + (cs)_M \approx 3256.0 \text{ MeV}$
$(bc)_M + (bu)_M \approx 3724.0 \text{ MeV}$
$(bc)_M + (bs)_M \approx 4901.0 \text{ MeV}$
$(bc)_M + (bc)_M \approx 6092.0 \text{ MeV}$
$(bc)_M + (u)_M \approx 3417.0 \text{ MeV}$
$(bc)_M + (ud)_M \approx 3464.0 \text{ MeV}$

$(bc)_M + (cs)_M \approx 4674.0 \text{ MeV}$
$(bc)_M + (bu)_M \approx 3724.0 \text{ MeV}$
$(bc)_M + (bd)_M \approx 3899.0 \text{ MeV}$
$(bc)_M + (bc)_M \approx 4901.0 \text{ MeV}$
$(bc)_M + (bc)_M \approx 6092.0 \text{ MeV}$
$(b_M + (u)_M \approx 4326.0 \text{ MeV}$
$(b_M + (ud)_M \approx 4373.0 \text{ MeV}$

$b_M + (cs)_M \approx 5583.0 \text{ MeV}$
$b_M + (bu)_M \approx 4633.0 \text{ MeV}$
$b_M + (bd)_M \approx 4808.0 \text{ MeV}$
$b_M + (bs)_M \approx 5810.0 \text{ MeV}$
$b_M + (bc)_M \approx 7001.0 \text{ MeV}$
$b_M + s_M \approx 5167.0 \text{ MeV}$
$b_M + c_M \approx 6432.0 \text{ MeV}$
$b_M + b_M \approx 7902.0 \text{ MeV}$

See the following table 7 for neutral top mesons.

**Table 7.** Estimated neutral up mesons to bottom mesons

$(ts)_M + (u)_M \approx 2586.0 \text{ MeV}$
$(ts)_M + (ud)_M \approx 2633.0 \text{ MeV}$
$(ts)_M + (d)_M \approx 2693.0 \text{ MeV}$
$(ts)_M + (su)_M \approx 2783.0 \text{ MeV}$
$(ts)_M + (sd)_M \approx 2901.0 \text{ MeV}$
$(ts)_M + (cu)_M \approx 2860.0 \text{ MeV}$
$(ts)_M + (cd)_M \approx 3016.0 \text{ MeV}$
$(ts)_M + (cs)_M \approx 3843.0 \text{ MeV}$

$(tb)_M + (u)_M \approx 4524.0 \text{ MeV}$
$(tb)_M + (ud)_M \approx 4571.0 \text{ MeV}$
$(tb)_M + (d)_M \approx 4631.0 \text{ MeV}$
$(tb)_M + (su)_M \approx 4721.0 \text{ MeV}$
$(tb)_M + (sd)_M \approx 4839.0 \text{ MeV}$
$(tb)_M + (cu)_M \approx 4798.0 \text{ MeV}$
$(tb)_M + (cd)_M \approx 4954.0 \text{ MeV}$
$(tb)_M + (cs)_M \approx 5781.0 \text{ MeV}$

$(tb)_M + (bu)_M \approx 5927.0 \text{ MeV}$
$(tb)_M + (bd)_M \approx 5685.0 \text{ MeV}$
$(tb)_M + (tu)_M \approx 7693.0 \text{ MeV}$
$(tb)_M + (td)_M \approx 4954.0 \text{ MeV}$
$(tb)_M + (bs)_M \approx 6008.0 \text{ MeV}$
$(tb)_M + (bc)_M \approx 7199.0 \text{ MeV}$
$(tb)_M + (b)_M \approx 8108.0 \text{ MeV}$
$(tb)_M + (tu)_M \approx 8108.0 \text{ MeV}$
$(tb)_M + (td)_M \approx 4874.0 \text{ MeV}$
$(tb)_M + (b)_M \approx 8108.0 \text{ MeV}$

$(tb)_M + (u)_M \approx 6418.0 \text{ MeV}$
$(tb)_M + (ud)_M \approx 6465.0 \text{ MeV}$
$(tb)_M + (d)_M \approx 6525.0 \text{ MeV}$
$(tb)_M + (su)_M \approx 6615.0 \text{ MeV}$
$(tb)_M + (sd)_M \approx 6733.0 \text{ MeV}$
$(tb)_M + (cu)_M \approx 6692.0 \text{ MeV}$
$(tb)_M + (cd)_M \approx 6848.0 \text{ MeV}$
$(tb)_M + (cs)_M \approx 7675.0 \text{ MeV}$

$11.1 \text{ Excited meson mass spectrum}$

Excited charged mesons levels can be expressed in the following way.
\[(Meson)_{\text{excited}} \cong n^{\frac{1}{4}} (Meson)_{\text{ground}}\]

where, \(n = 1, 2, 3, \ldots\)

See the following table 8 for ground and excited charged mesons.

**Table 8.** Ground and excited meson levels having charge \(\pm e\)

<table>
<thead>
<tr>
<th>(n)</th>
<th>(\frac{1}{n^2})</th>
<th>((ud)_{M}^{\pm e})</th>
<th>((su)_{M}^{\pm e})</th>
<th>((sd)_{M}^{\pm e})</th>
<th>((cu)_{M}^{\pm e})</th>
<th>((cd)_{M}^{\pm e})</th>
<th>((cs)_{M}^{\pm e})</th>
<th>((bu)_{M}^{\pm e})</th>
<th>((bd)_{M}^{\pm e})</th>
<th>((bs)_{M}^{\pm e})</th>
<th>((bc)_{M}^{\pm e})</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>418</td>
<td>568</td>
<td>686</td>
<td>645</td>
<td>801</td>
<td>1628</td>
<td>678</td>
<td>853</td>
<td>1855</td>
<td>3046</td>
</tr>
<tr>
<td>2</td>
<td>1.1892071</td>
<td>497</td>
<td>675</td>
<td>816</td>
<td>767</td>
<td>953</td>
<td>1936</td>
<td>806</td>
<td>1014</td>
<td>2206</td>
<td>3622</td>
</tr>
<tr>
<td>3</td>
<td>1.316074</td>
<td>550</td>
<td>748</td>
<td>903</td>
<td>849</td>
<td>1054</td>
<td>2143</td>
<td>892</td>
<td>1123</td>
<td>2441</td>
<td>4009</td>
</tr>
<tr>
<td>4</td>
<td>1.4142136</td>
<td>591</td>
<td>803</td>
<td>970</td>
<td>912</td>
<td>1133</td>
<td>2302</td>
<td>959</td>
<td>1206</td>
<td>2623</td>
<td>4308</td>
</tr>
<tr>
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<td>625</td>
<td>849</td>
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<td>964</td>
<td>1198</td>
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<td>889</td>
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<td>1009</td>
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<td>1061</td>
<td>1335</td>
<td>2903</td>
<td>4767</td>
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<td>7</td>
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<td>924</td>
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<td>1049</td>
<td>1303</td>
<td>2648</td>
<td>1103</td>
<td>1387</td>
<td>3017</td>
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</tr>
<tr>
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<td>1.6817928</td>
<td>703</td>
<td>955</td>
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<td>1140</td>
<td>1435</td>
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<td>1117</td>
<td>1387</td>
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<td>1174</td>
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<td>1147</td>
<td>1424</td>
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<td>761</td>
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<td>1491</td>
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<td>1588</td>
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<td>1.8988289</td>
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<td>3091</td>
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<td>1620</td>
<td>3522</td>
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<td>1099</td>
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<td>1248</td>
<td>1549</td>
<td>3149</td>
<td>1311</td>
<td>1650</td>
<td>3588</td>
<td>5892</td>
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<td>1.9679897</td>
<td>823</td>
<td>1118</td>
<td>1350</td>
<td>1269</td>
<td>1576</td>
<td>3204</td>
<td>1334</td>
<td>1679</td>
<td>3651</td>
<td>5994</td>
</tr>
</tbody>
</table>

**Points to be noted:**

1) Ground or excited quark mesons couple with light quark bosons like up boson of mass 1.91 MeV/c^2, down quark boson of mass 4.08 MeV/c^2 and strange quark boson of mass 66.5 MeV/c^2 and generate light neutral mesons.

2) Currently believed mesons like 497 and 547 MeV can be understood with excited \((ud)_{M}^{\pm e}\) levels. See the following table 9.

3) Currently believed other light mesons can be understood with excited \((ud)_{M}^{\pm e}\), \((su)_{M}^{\pm e}\), \((sd)_{M}^{\pm e}\) and \((cu)_{M}^{\pm e}\), \((cd)_{M}^{\pm e}\) levels.

4) Currently believed charmed meson of rest energy 1869 MeV can be compared with ground state \((bs)_{M}^{\pm e}\) level of 1855 MeV. Similarly, currently believed charmed meson of rest energy 2460 MeV can be compared with 3rd excited level of \((bs)_{M}^{\pm e}\) level of 2441 MeV.
5) Currently believed charged charm-strange mesons can be understood with \((cs)^{±e}_M\) levels. For example, 1968 MeV can be compared with estimated 1936 MeV. 2112 MeV can be compared with estimated 2143 MeV, 2317 MeV can be compared with 2302 MeV, 2460 MeV can be compared with 2434 MeV, 2536 can be compared with 2548 MeV and 2709 can be compared with 2768 MeV.

6) Currently believed bottom mesons, bottom strangemeson, bottom charm mesons can be understood with \((bc)^{±e}_M\) levels.

### 11.2 Ground & Excited Neutral Kaons

Currently believed strange mesons like 497 MeV, 547 MeV can be considered as the excited levels of meson \((ud)^{±e}_M\) of rest energy 418 MeV. Excited levels couple with up quark boson and down quark boson and generate neutral mesons

<table>
<thead>
<tr>
<th>(n)</th>
<th>(\frac{1}{n^2})</th>
<th>((ud)^{±e}_M) levels</th>
<th>((ud)^{±e}_M) level+ (u^+_b)</th>
<th>((ud)^{±e}_M) level+ (d^+_b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>418</td>
<td>420</td>
<td>422</td>
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<td>2</td>
<td>1.1892071</td>
<td>497</td>
<td>499</td>
<td>501</td>
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<td>1.316074</td>
<td>550</td>
<td>552</td>
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<td>1.4142136</td>
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<td>726</td>
<td>728</td>
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<tr>
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<td>1.7782794</td>
<td>743</td>
<td>745</td>
<td>747</td>
</tr>
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<td>1.8211603</td>
<td>761</td>
<td>763</td>
<td>765</td>
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<td>12</td>
<td>1.8612097</td>
<td>778</td>
<td>780</td>
<td>782</td>
</tr>
</tbody>
</table>

In this table 9, at \(n=2\), estimated 497 MeV can be compared with charged 493 MeV kaon. Neutral 499 MeV or neutral 501 MeV can be compared with neutral kaon of rest energy 497 MeV.

### 11.3 Currently Believed Bottom-anti Bottom Mesons

The following points can be given some consideration in understanding the currently believed bottom-anti-bottom mesons.
1. Charged bottom meson transforms to second generation bottom meson with the following relation.

\[ b_{M_2}c^2 \approx \frac{1}{2k}\left[(m_{c}c^2)^2(b_{M_1}c^2)\right]^{\frac{1}{3}} \]

where \( b_{M_2} \) can be called as second generation bottom meson and \( b_{M_1} \) can be called as first generation bottom meson.

2. Excited levels of \((b)_{M_2}\) can be estimated as follows.

\[ (b_{M_2})_n c^2 \approx \frac{\sin \theta_W}{2} \left[(45557)^2(3955)\right]^{\frac{1}{3}} \approx 4730 \text{ MeV} \]

3. \( n^{th} \) excited state couples with oppositely charged \( n, (n-1), (n-2), (n-3), \ldots \) excited states and generates \( n \) number of neutral mesons. See the following table -10.

**Table 10. Ground and excited levels of \((b)_{M_2}^{\pm}\)**

<table>
<thead>
<tr>
<th>( n )</th>
<th>( \frac{1}{n^{12}} )</th>
<th>( (b)_{M_2}^{\pm} ) levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>4730</td>
</tr>
<tr>
<td>2</td>
<td>1.059463</td>
<td>5011</td>
</tr>
<tr>
<td>3</td>
<td>1.095873</td>
<td>5183</td>
</tr>
<tr>
<td>4</td>
<td>1.122462</td>
<td>5309</td>
</tr>
<tr>
<td>5</td>
<td>1.14353</td>
<td>5409</td>
</tr>
<tr>
<td>6</td>
<td>1.161037</td>
<td>5492</td>
</tr>
<tr>
<td>7</td>
<td>1.176047</td>
<td>5563</td>
</tr>
<tr>
<td>8</td>
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</tr>
<tr>
<td>9</td>
<td>1.200937</td>
<td>5680</td>
</tr>
<tr>
<td>10</td>
<td>1.211528</td>
<td>5731</td>
</tr>
</tbody>
</table>

4. At \( n=1 \), 19460 MeV can be generated

5. At \( n=2 \), 9741 MeV and 10022 MeV can be generated.

6. At \( n=3 \), 9913 MeV, 10194 MeV and 10366 MeV can be generated.

7. At \( n=4 \), 10039 MeV, 10320 MeV, 10492 MeV and 10618 MeV can be generated.

8. At \( n=5 \), 10139 MeV, 10420 MeV, 10592 MeV, 10718 and 10818 MeV can be generated.

9. At \( n=6 \), 10222 MeV, 10503 MeV, 10675 MeV, 10801 MeV, 10901 MeV and 10984 MeV can be generated.
11.4 Fitting & Understanding the Currently Believed Tetra Quark Mesons

Currently believed charged tetra mesons 3900 MeV, 4050 MeV, 4250 MeV, 4430 MeV etc. can be fitted in the following way.

1. Charged bottomstrange meson transforms to second generation bottom strange meson with the following relation.

\[
\left( {bs} \right)_{M2} c^2 \approx \frac{1}{2K} \left( m_{M2} c^2 \right)^2 \left( \left( {bs} \right)_{M1} c^2 \right)^{\frac{1}{2}} \\
\approx \frac{\sin \theta_W}{2} \left[ (45557)^2 (1855) \right]^\frac{1}{3} \approx 3675 \text{ MeV}
\]

(50)

where \( (bs)_{M2} \) can be called as second generation \( bs \) meson and \( (bs)_{M1} \) can be called as first generation \( bs \) meson.

2. Charged excited levels of \( (bs)_{M2} \) can be estimated as follows.

\[
\left( (bs)_{M2} \right)_n c^2 \approx \frac{\sin \theta_W}{2} \left[ (45557)^2 \left( \frac{1}{n^2} 3675 \right) \right]^\frac{1}{3} \approx \frac{1}{n^{12}} * 3675 \text{ MeV}
\]

(51)

See the following table 11.

<table>
<thead>
<tr>
<th>( n )</th>
<th>( n^2 )</th>
<th>( (bs)_{M2}^{3c} ) levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3675</td>
</tr>
<tr>
<td>2</td>
<td>1.0594631</td>
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</tr>
<tr>
<td>3</td>
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</tr>
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<tr>
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</tr>
</tbody>
</table>

3. With further research and analysis, other predicted levels can be discovered.
12. Conclusion

With strong gravity concepts and supersymmetry, we proposed in this paper several unified concepts, relations and data fitting procedures for understanding the observed nuclear elementary particles and predicted several new particle levels. With further research and analysis, we are confident that currently believed quark theory can be refined and simplified.

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