A Generalized Unified Electro-Gravity (UEG) Model Applicable to All Elementary Particles

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The Unified Electro-Gravity (UEG) theory, originally developed to model an electron, is generalized to model a variety of composite charged as well as neutral particles, which may constitute all known elementary particles of particle physics. A direct extension of the UEG theory for the electron is possible by modifying the functional dependence between the electro-gravitational field and the energy density, which would lead to a general class of basic charged particles carrying different levels of mass/energy, with the electron mass at the lowest level. The basic theory may also be extended to model simple composite neutral particles, consisting of two layers of surface charges of equal magnitudes but opposite signs. The model may be similarly generalized to synthesize more complex structures of composite charged or neutral particles, consisting of increasing levels of charged layers. Depending upon its specific basic or composite structure, a particle could be highly stable like an electron or a proton, or relatively unstable in different degrees, which may be identified with other known particles of the standard model of particle physics. The generalized UEG model may provide a new unified paradigm for particle physics, as a substitute for the standard model currently used, making the weak and strong forces of the standard model redundant.

I. INTRODUCTION

The Unified Electro-Gravity (UEG) theory was successfully established in [1] to model an ideal "static electron," without spin. In this theory, the electro-gravitational field, referred to as the UEG field, is assumed to be proportional to the energy density, with the constant of proportionality referred to as the UEG constant. Stable solutions in this model include discrete levels of mass/energy, where the lowest possible mass/energy state is recognized as a static electron, and differences between the energy levels are found to be small as compared to the energy of the electron. From the solutions, it is clear that the basic form of the theory [1] can neither model a proton, which is another stable charged particle in common occurrence, with significantly larger mass than electron, nor a neutron, which is also in common occurrence but carries a zero total charge, nor many other known charged or neutral particles in the standard model of particle physics. In order that the UEG theory can be established as a truly unified theory, it needs to generalized for application to all known charged or neutral particles.

The UEG theory may be extended by having the UEG field to be dependent on higher powers of the energy density, expressed in terms of a general function of the energy density, referred to as a UEG function. With a suitable form of the UEG function, stable solutions for a charged particle with higher levels of mass/energy would be possible, where a stable solution in the next higher level following the electron maybe identified as a proton. The general UEG function may be properly approximated, with discrete values of the UEG function for the different levels of the stable solutions. A general UEG model with such a discretized approximation of the general UEG function maybe treated analytically equivalent to a basic UEG model of [1] with a fixed UEG constant, by associating different discrete values of the UEG constant to the different levels of stable mass. Accordingly, the derivations and results in the basic UEG model of the electron [1] maybe directly applicable to model the higher levels of stable particles, by simply substituting the UEG constant with a specific different value for a different level of stable mass. Consequently, a fundamental dimensionless constant, which relates the UEG constant, the stable mass and the associated classical radius, as established in [1] in relation to the fine structure constant, would in principle remain valid for all levels of the stable solutions. This would be a significant development, which would indicate that the UEG theory, to which the dimensionless fine-structure constant may trace its fundamental origin, can be much general in its scope of application to a broad class of - possibly all - charged particles, independent of any specific configuration or mass of the particle.

The derivations of the UEG theory of [1] may also be extended, with reasonable additional effort, to model a general class of composite neutral particles, consisting of a general internal charge structure which is enclosed by an external layer of charge of equal magnitude but opposite in sign, as compared to the total internal charge. A special class of such neutral particles (the zeroth kind) may be identified as neutrinos, when two oppositely charged layers are very closely spaced, resulting in significantly lower mass of the neutral particles than those associated with their internal charge structure without the external charge layer. A composite neutral particle, made of a negative charge layer that encloses a positively-charged layer of a proton, having the total mass close to that of the proton, maybe identified as a neutron. The mass/energy of any general composite neutral particle may be related to that of the internal charge structure, and values of different critical energies, using simple formulations, based on the results of [1]. For a special configuration of the neutral particles (the first kind), the above formulations may need to be numerically solved. In this case, the factor (meson factor) relating the mass of a synthesized neutral particle and that associated with its internal charge structure maybe numerically calculated, that can be tabulated or plotted in a general normalized form for convenient use to model any neutral particle of the special kind.

The above modelings may be extended, formulated in the most general form, to model increasingly complex structures of composite charged or neutral particles. They can be synthesized using multiple charge layers, arranged in multiple levels and sub-levels (shells), and be associated with different orders of stability depending on the specific structure. Such a large class of general particles maybe identified with all known particles in the standard model of particle physics. Depending on the specific charge structure and associated stability, a particle may be identified as a baryon, meson, lepton, or a basic boson, representing all observed particles covered by the standard model of particle physics [2–4]. Such a generalized UEG model would provide a new paradigm that may completely replace the standard model, making the basic weak and strong forces of the standard model [5, 6] redundant. In other words, the electromagnetic and gravitational forces, which were successfully unified through the basic UEG theory of [1], could be effectively unified as well with the hypothetical weak and strong forces of particle physics, through the generalization established in the present work. That would be a remarkable development in modern physics.

All the models presented in the paper are explicitly valid for ideal static particles, that do not include spin. The Plank's constant, which is twice the spin angular momentum of a fermionic (baryon and lepton) particle, should be indirectly related to the UEG constant through their shared relationship with the fine-structure constant, discussed earlier. This may suggest that spin dynamics, described by the Plank's constant, could be closely related to the UEG theory. Accordingly, the UEG theory could conceivably be extended to dynamic modeling of a spinning particle at any general level, where the central acceleration of the spinning particle would be supported by the UEG effects of the particle's own electric and magnetic fields. Such an extended dynamic UEG model maybe separately explored [7], beyond the scope of the present paper. However, for useful mass estimations in this paper, we may simply assume that the total mass/energy of an elementary spinning charge at any given level is about twice that of a static charge at the level without the spin [1, 7]. Accordingly, for all calculations in this paper, the mass in a given level maybe assumed to be twice or equal to the UEG static mass [1] in the particular level, depending on if the spin contribution in the level is included or not, respectively.

II. A GENERAL UEG THEORY, WITH HIGHER ORDER FUNCTIONAL DEPENDENCE OF THE UEG ACCELERATION ON ENERGY DENSITY

In the basic UEG theory of [1], the UEG acceleration $\overline{E}_g = -\frac{4\pi G}{c^2}\overline{U} = -\frac{4\pi G}{c^2}\zeta W_\tau \hat{r}$ was expressed in the simplest form, proportional to the energy density W_τ, with the proportionality constant $\gamma = \frac{4\pi G}{c^2}\zeta$. The basic UEG theory of [1] may be extended using a general functional form of the function $\overline{U} = \hat{r}U(W_\tau)$, dependent on the energy density W_τ. This may be treated as equivalent to substituting the UEG constant parameter γ used in [1] with a general UEG function $\gamma(W_\tau)$. For analytical simplicity, the UEG function $\gamma(W_\tau)$ maybe treated with a "stair-case" approximation, having different discrete values of γ for different ranges of the flux density D, or for the corresponding ranges of the radial distance r, as shown in Fig.1.

$$\begin{aligned}\overline{U} &= \hat{r}U(W_\tau) = \hat{r}\zeta(W_\tau)W_\tau,\\ \overline{\nabla}\cdot\overline{E}_g &= -\frac{4\pi G}{c^2}(W_\tau + \overline{\nabla}\cdot\overline{U}) \simeq -\frac{4\pi G}{c^2}\overline{\nabla}\cdot\overline{U}\\ &= -\frac{4\pi G}{c^2}\overline{\nabla}\cdot(\hat{r}\zeta(W_\tau)W_\tau) = -\overline{\nabla}\cdot(\gamma(W_\tau)W_\tau\hat{r})\quad . \end{aligned} \tag{1}$$

$$\begin{aligned}\gamma(W_\tau) &= \frac{4\pi G}{c^2}\zeta(W_\tau) = \gamma_1\frac{1+\alpha_1' W_\tau^2+\alpha_2' W_\tau^4+\alpha_3' W_\tau^6+\cdots}{1+\alpha_1 W_\tau^2+\alpha_2 W_\tau^4+\alpha_3 W_\tau^6+\cdots}\\ &= \gamma_1\frac{(1+(\frac{W_\tau}{W'_{\tau10}})^2)(1+(\frac{W_\tau}{W'_{\tau20}})^2)(1+(\frac{W_\tau}{W'_{\tau30}})^2)\cdots}{(1+(\frac{W_\tau}{W_{\tau10}})^2)(1+(\frac{W_\tau}{W_{\tau20}})^2)(1+(\frac{W_\tau}{W_{\tau30}})^2)\cdots}\\ &\cong \gamma_1\frac{(1+(\frac{D}{D'_{10}})^4)(1+(\frac{D}{D'_{20}})^4)(1+(\frac{D}{D'_{30}})^4)\cdots}{(1+(\frac{D}{D_{10}})^4)(1+(\frac{D}{D_{20}})^4)(1+(\frac{D}{D_{30}})^4)\cdots}\\ &= \gamma_1\frac{(1+(\frac{r'_{10}}{r})^8)(1+(\frac{r'_{20}}{r})^8)(1+(\frac{r'_{30}}{r})^8)\cdots}{(1+(\frac{r_{10}}{r})^8)(1+(\frac{r_{20}}{r})^8)(1+(\frac{r_{30}}{r})^8)\cdots}, \end{aligned} \tag{2}$$

$$\begin{aligned}&\gamma \simeq \gamma_1,\ r > r_{10};\ \gamma \simeq \gamma_2 = \gamma_1(\frac{r'_{10}}{r_{10}})^8,\ r_{10} > r > r_{20};\\ &\gamma \simeq \gamma_3 = \gamma_1(\frac{r'_{10}}{r_{10}})^8(\frac{r'_{20}}{r_{20}})^8,\ r_{20} > r > r_{30};\\ &\gamma \simeq \gamma_i = \gamma_1(\frac{r'_{10}}{r_{10}})^8(\frac{r'_{20}}{r_{20}})^8\cdots(\frac{r'_{(i-1)0}}{r_{(i-1)0}})^8,\ r_{(i-1)0} > r > r_{i0}. \end{aligned} \tag{3}$$

The basic mass (energy) function $m(r)$ ($W(r) = m(r)c^2$), which is the total mass (energy) of an elementary spherical charge layer placed at radius r, and the inverse relative-permittivity function $\underline{\epsilon}_r(r)$ which is the inverse of the relative permittivity seen at the charge layer at radius r, maybe derived (see the sketches in Figs.2, 3) using the basic UEG theory of [1], based on the stair-case approximation of (3) for the γ. The radii where the mass function is stable would represent stable elementary charge particles. The mass and radii of such stable

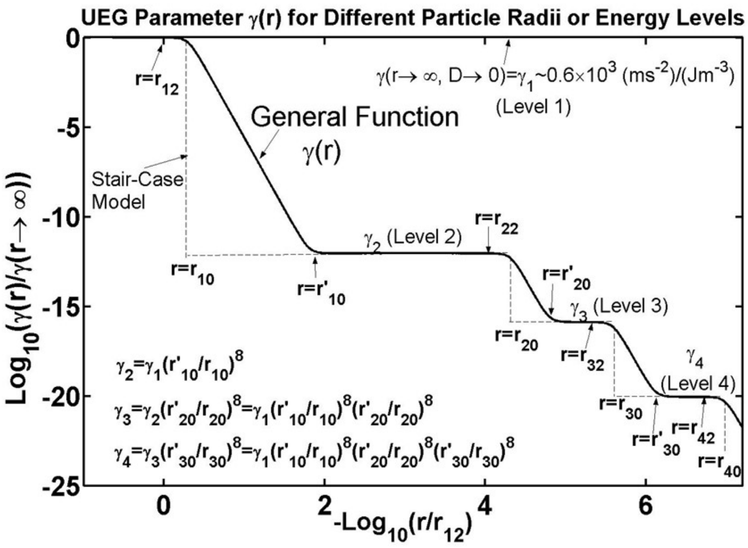


FIG. 1.

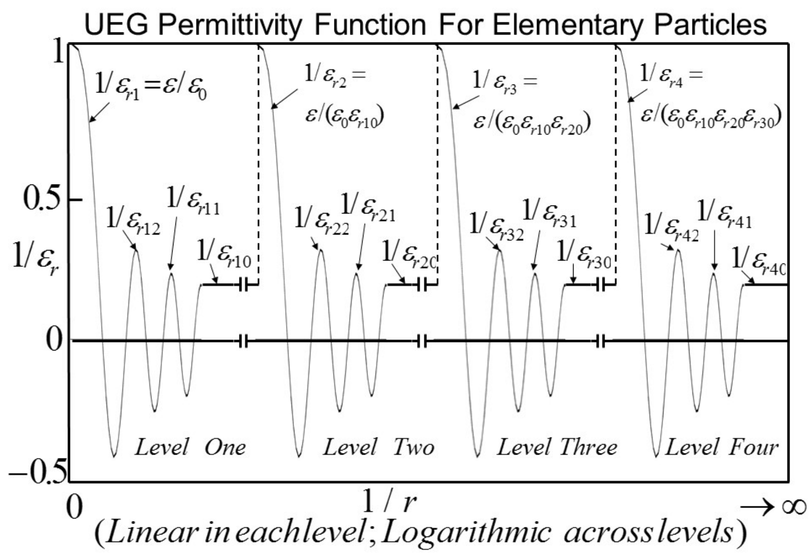


FIG. 2.

charged particles may be indexed as m_{ij} and r_{ij}, respectively, in reference to a particular level i of the general UEG theory, and a particular shell j (= 1, 2) in the given level (see Figs.4, 5).

Note that the mass profile $m(r)$ in a given level i refers to an ideal derivation in the absence of all levels lower than i, with a fixed UEG constant γ for the given level that is valid for all r to infinite distance. However, in the presence of a neighboring lower level $(i-1)$, the mass $m(r)$ associated with the level i needs to be properly truncated at the boundary of the level $(i-1)$ at $r = r_{(i-1)0}$, resulting in the effective truncated mass $m_t(r)$ to be valid only for $r < r_{(i-1)0}$, with an initial condition $m_t(r = r_{(i-1)0}) = 0$, and $m_t(r < r_{(i-1)0})$ equal to $m(r) - m(r = r_{(i-1)0})$. Therefore, to be particular, any mass $m_{ij} = m(r = r_{ij})$ listed in Table V actually refers to the respective truncated value $m_t(r = r_{ij})$, which would be exactly and approximately equal to its ideal non-truncated value, respectively for levels 1 and 2, but be somewhat lower than the ideal value for levels 3 and 4.

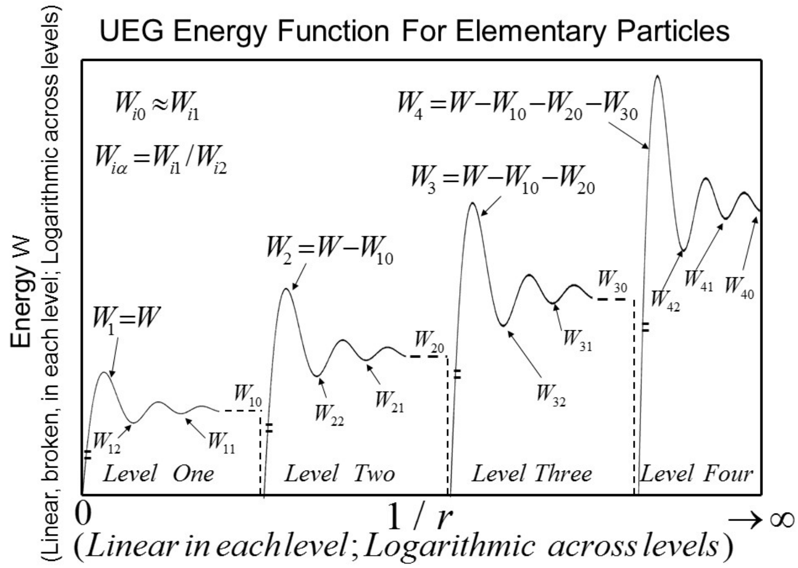


FIG. 3.

In addition to the stable elementary charge particles, various kinds of neutral particles that carry zero total charge, as well as various composite charge particles combining the neutral and the stable elementary particles, can be synthesized based on certain basic principles of the UEG theory [1]. A basic neutral particle may consist of two elementary charges of opposite signs, placed at two different radii. Alternatively, a neutral particle may consist of an internal composite charge ($\pm q$) structure surrounded by an external elementary charge ($\mp q$) layer, with zero total charge. This way a large number of particles could be synthesized from the UEG theory, consisting of all particles (leptons, baryons and mesons) as well as different force carriers (bosons), and possibly even other particles that have not yet been discovered or are not practically realized because suitable decay paths might not be realized in particle-collision experiments. Such particle synthesis using the UEG theory would provide a complete, alternate model to the existing standard model of the particle physics [5, 6].

The stability of a neutral or a composite charge particles is determined by the stability of the individual parts of its total structure. Accordingly, such particles may be stable or "quasi-stable" depending on if all or most parts are definitively stable, while any remaining parts are only quasi-stable. The two different kinds of stability of the parts, referred to here, are analogous to having a massive particle on earth placed inside a bowl, or on top of an inverted bowl, where the first kind is definitively stable and the second kind is conditionally stable or quasi-stable. A quasi-stable state would represent a transient state that would decay into stable particles, or other quasi-stable particles that are relatively more stable, having lower total mass/energy. Even a definitively stable particles, with availability of enough energy to overcome its local "energy valley", may decay into other stable or quasi-stable particles of lower mass/energy. This will determine possible decay paths and associated transient times for the different particles.

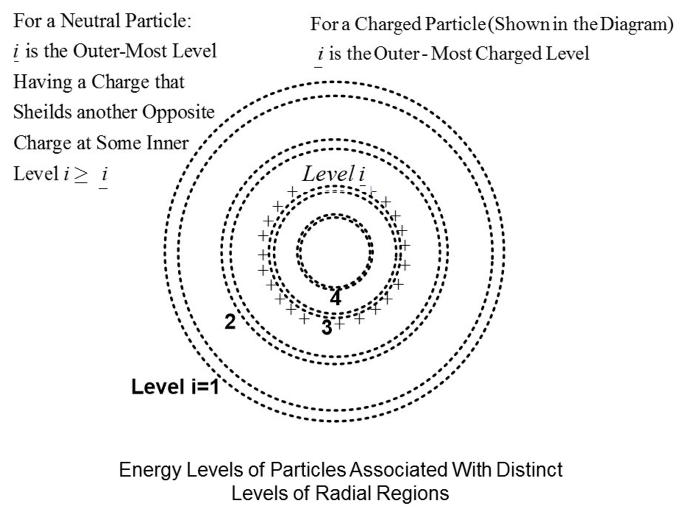
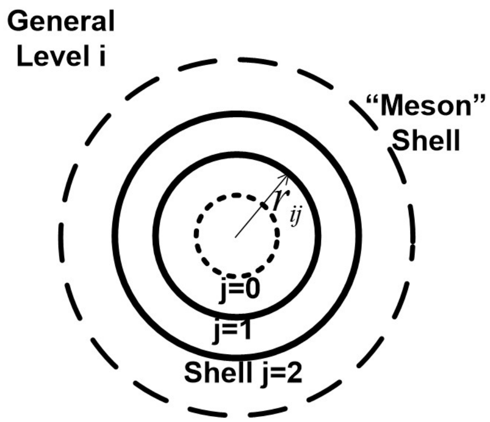


FIG. 4.

In the following we will separately discuss the individual types of neutral or composite charge particles.



Details of the Radial Region for One Energy Level (i), Having Shells (j) of Finer Structures with Critical Radii r_{ij} and Associated Mass/Energy Sub-Levels m_{ij}

FIG. 5.

III. NEUTRINO: A NEUTRAL PARTICLE OF THE ZEROTH KIND, WITH OPPOSITELY CHARGED LAYERS CLOSE TO EACH OTHER.

A. Neutrino for the First Level, Based on the Basic UEG Model

We will first consider the basic UEG model, which is applicable to the level one. Similar results can then be extended to the general UEG model as applicable to any higher level.

The inverse-permittivity function $\underline{\epsilon}_r(r)$ (see Fig.2) of the basic UEG theory [1] (or a general UEG theory for any higher level) oscillates around $\underline{\epsilon}_r = 0$. Given $\underline{\epsilon}_r(r = r_{n0}) = 0$, two layers of opposite charges at radii close to but slightly (infinitesimally) larger than r_{n0}, $r_2 > r_1 > r_{n0}$, would produce a stable synthesized neutral particle having a relatively small, non-zero mass. Such a particle is recognized as an electron neutrino [8–10]. The oppositely charge layers in the above configuration, when they are closely spaced around any other radii where $\underline{\epsilon}_r \neq 0$ would result in a theoretically stable body but with a zero mass/energy. It may be noted, if the two radii r_1 and r_2, $r_2 > r_1$, are close to each other but both are smaller than r_{n0}, it can be shown to result in a negative, unstable energy. This case is not considered in the following detailed analyses because the resulting negative, unstable energy would not represent any physical particle.

Based on the UEG theory [1], given the mass $m(r)$ and the inverse relative-permittivity $\underline{\epsilon}_r(r)$ profiles of an elementary charge particle, the mass $m_{sn}(r_1, r_2)$ of a composite neutral body, synthesized with two elementary charges ($\pm q$) of opposite signs, placed at radii r_2 and r_1, $r_2 > r_1$, can be expressed as:

$$m_{sn}(r_1, r_2) = [m(r_1) - m(r_2)]/\underline{\epsilon}_r(r_2),\ r_1 < r_2. \quad (4)$$

The electric fields due to the two layers of charges of equal magnitude but opposite signs would cancel with each other, resulting in zero total field and its associated energy density, in the external region ($r > r_2$). Accordingly, the equivalent mass $m(r_2)$ associated with the energy in the external region, produced due the inner charge layer ($+q$) placed at $r = r_1$ (without presence of the outer charge ($-q$) layer at $r = r_2$), is first subtracted in (4) from the total mass/energy $m(r_1)$. Further, the inverse relative-permittivity $\underline{\epsilon}_r$ in the external region ($r > r_2$) of the composite neutral body is assumed to be unity, which needs to be continuous with that in the region between the two charge layers across the external boundary at $r = r_2$. Therefore, the original $\underline{\epsilon}_r(r)$ function due to the the inner charge ($+q$) (without presence of the external charge ($-q$)) needs to be scaled by multiplying it with the factor $1/\underline{\epsilon}_r(r = r_2)$, in order to obtain the new inverse relative-permittivity function of the composite neutral particle that would be valid in the region between its two charge layers $r_1 < r < r_2$. Consequently, the original energy content ($m(r_1) - m(r_2)$) between the two charge layers, as discussed above, also needs to be multiplied by the same factor ($1/\underline{\epsilon}_r(r = r_2)$) in order to find the actual new mass of the composite neutral particle. This is because the mass/energy scales in proportion to the inverse relative permittivity [1].

Now, based on (4), the m_{sn} would be zero as $r_1 \to r_2$, except when $\underline{\epsilon}_r(r_2)$ is zero.

$$\begin{aligned} &r_1 \to r_2,\ m_{sn} \to 0,\ \underline{\epsilon}_r(r_2) \neq 0; \\ &m_{sn} \neq 0,\ \underline{\epsilon}_r(r_2) \to \underline{\epsilon}_r(r_{n0}) = 0. \end{aligned} \quad (5)$$

An approximate model for the $m(r)$ and $\underline{\epsilon}_r(r)$ near $r = r_{n0}$ may be used, in order to simplify the model for the resulting mass m_{sn} of the synthesized neutral particle, and its derivative with respect to r, from which specific conclusions may be conveniently established. Note that the derivatives of $m(r)$ and $\underline{\epsilon}_r(r)$ with radius r, at $r = r_{n0}$, are of opposite signs (see Figs.2, 3 and [1]), represented by the variables $\pm\alpha$ and $\mp\beta$; $\alpha, \beta > 0$, respectively.

$$\begin{aligned} &r = r_{n0} + \delta r,\ r_2 = r_{n0} + \delta r_2,\ r_1 = r_{n0} + \delta r_1, \\ &m(r) \simeq m(r_{n0}) \pm \alpha(\delta r) = m_0 \pm \alpha(\delta r),\ \alpha > 0, \\ &\underline{\epsilon}_r(r) = \underline{\epsilon}_r(r_{n0}) \mp \beta(\delta r) = \mp\beta(\delta r),\ \underline{\epsilon}_r(r_{n0}) = 0,\ \beta > 0, \\ &m_{sn}(\delta r_1, \delta r_2) = [m(r_1) - m(r_2)]/\underline{\epsilon}_r(r_2) \\ &= [\pm\alpha(\delta r_1) \mp \alpha(\delta r_2)]/(\mp\beta(\delta r_2)) = \frac{\alpha}{\beta}[1 - \frac{\delta r_1}{\delta r_2}]; \\ &\frac{\partial m_{sn}}{\partial(\delta r_2)} > 0,\ \delta r_1 > 0;\ \frac{\partial m_{sn}}{\partial(\delta r_1)} < 0;\ \delta r_2 > 0. \end{aligned} \quad (6)$$

As mentioned earlier, we assume $r_2 \geq r_1$ as required or assumed in the above mass formula.

$$r_2 \geq r_1;\ r_2 = r_{n0} + \delta r_2,$$
$$r_1 = r_{n0} + \delta r_1,\ \delta r_2 \geq \delta r_1. \quad (7)$$

When $r_2 = r_1 = r_{sn}$, the resulting m_{sn} of (6) can be shown to be zero, as anticipated earlier, for all r_{sn} other than $r_{sn} = r_{n0}$, or for all $\delta_{rn} \neq 0$.

$$\delta r_2 = \delta r_{2n},\ \delta r_1 = \delta r_{1n};\ r_1 = r_{sn1},\ r_2 = r_{sn2};$$
$$r_{sn1} \leq r_{sn2},\ \delta r_{1n} \leq \delta r_{2n};$$
$$r_{sn1} = r_{sn2} = r_{sn};\quad \delta r_{2n} = \delta r_{1n} = \delta r_n,\ r_{sn} = r_{n0} + \delta r_n;$$
$$m_{sn}(\delta r_1 = \delta r_{1n} = \delta r_n, \delta r_2 = \delta r_{2n} = \delta r_n)$$
$$= \frac{\alpha}{\beta}[1 - \frac{\delta r_{1n}}{\delta r_{2n}}] = 0,\ \delta r_n \neq 0. \quad (8)$$

Following the above case with $r_1 = r_2 = r_{sn}$, only when $r_{sn} > r_{n0}$, $\delta r_n > 0$, it is a stable point as can be shown from the derivative of the approximate mass expression (6) . Note that when $r_1 = r_2$, the stability condition is different from a standard stability condition (having the first derivative of the energy/mass function with respect to the radius equal to zero and the second derivative negative for both the radius variables r_1 and r_2) used elsewhere when $r_1 \neq r_2$. In this case with $r_1 = r_2 = r_{sn}$, we need a positive energy derivative with respect to r_2 for r_2 larger than the stable point, and a negative derivative with r_1, for r_1 less than the stable point (so called, a "V" type of stability).

$$r_{sn} = r_{n0} + \delta r_n > r_{n0};\ \delta r_{2n} = \delta r_{1n} = \delta r_n > 0,$$
$$\frac{\partial m_{sn}}{\partial(\delta r_2)} > 0,\ \delta r_1 = \delta r_n > 0;$$
$$\frac{\partial m_{sn}}{\partial(\delta r_1)} < 0,\ \delta r_2 = \delta r_n > 0. \quad (9)$$

Consider the limiting case, when the above stable point r_{sn} approaches r_{n0} from the larger side, which is equivalent to having δr_n positively approaching zero ($\delta r_n \to 0_+$). More specifically, we have $\delta r_{2n} \geq \delta r_{1n} \geq 0$, and they both approach the same value $\delta r_n = 0$, but the δr_{1n} is closer to zero than the δr_{2n}. The limiting stable mass in this case is not necessarily zero, having a range of possible positive values between zero and (α/β).

$$m_{sn}(\delta r_{1n}, \delta r_{2n}) = \frac{\alpha}{\beta}[1 - \frac{\delta r_{1n}}{\delta r_{2n}}],\ \delta r_{1n} \leq \delta r_{2n};$$
$$\frac{\alpha}{\beta} \geq m_{sn}((\delta r_{1n} \to 0) \leq \delta r_{2n}, \delta r_{2n} \to 0) \geq 0. \quad (10)$$

It may also be noted, that the original inverse relative-permittivity $\underline{\epsilon}_r(r)$, which is unity at $r \to \infty$, corresponds to a standard light speed $c(r \to \infty) = c_0$. In contrast, the scaled inverse relative-permittivity $\underline{\epsilon}_r(r)/\underline{\epsilon}_r(r = r_2)$, valid for $r_1 \leq r \leq r_2$ between the charges at radii $r = r_1, r_2$ (discussed earlier), is equal to $1/\underline{\epsilon}_r(r = r_2)$ at $r \to \infty$, which is greater than unity in magnitude, approaching infinity for $r_2 \to r_{n0}$. The corresponding light speed in this case $c(r \to \infty)$ is larger than the standard light speed c_0, approaching infinity for $r_2 \to r_{n0}$. Accordingly, the speed limit in the medium between the charges $r_1 \leq r \leq r_2$ is no longer governed by the standard light speed c_0, but by the new light speed $c(r \to \infty)$ which could approach infinity for $r_2 \to r_{n0}$. This would allow the charges to spin at speeds greater than c_0, even approaching infinite speed for $r_2 \to r_{n0}$. This is a remarkable new understanding, which would allow the neutral particle to have a significant, non-zero spin angular momentum (as expected from a fermion), even though the total mass is expected to be relatively small or negligible. Such a particle with a small mass, which could even approach zero, but with a non-zero spin angular momentum ($= \hbar/2$), may clearly be identified as an electron neutrino [8–10], which is a spin-half particle grouped under leptons in the standard model of particle physics [4, 6].

The ratio (α/β) in (10) maybe estimated based on the $m(r)$ and $\underline{\epsilon}_r(r)$ profiles for the level 1 ([1], Figs.2, 3), to be of the order of 5000 eV or so. As per (10), this places only an upper limit, predicting the mass of an electron neutron to be actually any value between zero and about 5000 eV, likely much smaller than the $5000eV$ limit, as per measured estimates [8]. The upper limit could also be significantly reduced by a more rigorous UEG model. A reference (data-fit) value of 50 eV (= 0.5Mev (electron mass) x 0.0001 (neutron factor)) for this upper limit is adopted in Table III, such that an extension of the UEG theory of the electron neutron to predict similar upper limits for the masses of the muon- and tauon- neutrinos, as presented in the following, would also be consistent with respective measured estimates (see Table III) [8].

B. Neutrino at Higher Levels, Based on a General UEG Model

The above neutrino analysis using the basic UEG theory for the level 1, may be similarly extended to a general model applicable to any level. The resulting neutrino in the second and third levels may be identified as the muon and tau neutrinos, respectively [8, 11, 12]. For such a general model, the basic mass function $m(r)$ and inverse-permittivity function $\underline{\epsilon}_r(r)$ in the above analysis maybe substituted by the respective functions $m_i(r)$ and $\underline{\epsilon}_{ri}(r)$ for a particular level i. Accordingly, the final neutrino mass m_{sni} for the level i can be obtained from the mass m_{sn1} for the level 1 by simply multiplying m_{sn1} by a normalization factor m_{i2}/m_{12}.

$$m_{sni} = m_{sn1} m_{i2}/m_{12} = (m_{sn1}/m_{12}) \times m_{i2}. \quad (11)$$

(m_{sn1}/m_{12}) is a useful factor, referred as the neutrino factor, which describes the neutrino mass m_{sni} at a given level as a fraction of the mass m_{i2} of an elementary charge at the respective level.

It may also be noted that in the general higher-order UEG model, for notational and formulational convenience a synthesized neutral mass m_{sni} at any given level i is a standard theoretical mass which assumes that the surrounding external medium has a reference relative permittivity equal to that $(=(\epsilon_{r(i-1)0}\epsilon_{r(i-2)0}\cdots(\epsilon_{r00}=1)))$ seen by an elementary charge particle in the level i. This is a hypothetical situation. The actual mass in a practical case, when the external medium is the free space with $\epsilon_{r00}=1$, would be equal to the standard mass m_{sni} multiplied by the above reference relative permittivity.

$$m_{sni}(\text{actual}) = m_{sni}/ (\underline{\epsilon}_{r(i-1)0}\underline{\epsilon}_{r(i-2)0}\cdots\underline{\epsilon}_{r10}(\underline{\epsilon}_{r00}=1)). \quad (12)$$

Such a relationship between an m_{sni}(actual) and its theoretical value m_{sni} would apply as well for any other kind of synthesized neutral particle, covered in the following sections IV and V.

IV. NEUTRAL PARTICLE OF THE FIRST KIND, WITH AN EXTERNAL CHARGE IN A "MESON SHELL", AND AN INTERNAL OPPOSITELY CHARGED BODY PLACED AT THE SAME OR A DIFFERENT LEVEL

A neutral particle may be synthesized with opposite charges placed at the same or different levels i and i'; $i' \geq i$. The charge at the inner level i' may be placed at a shell $j' = 1, 2$ at a radius $r_{i'j'}$, and the opposite charge of the outer level i is placed at a special shell n referred to as the "neutral shell" or "meson shell", which is different from a regular shell $j = 1, 2$. The name of this special shell is in reference to synthesis of mesons, which often uses this cell to produce relatively lower-mass particles (compared to baryons). Unlike the regular shells $j = 1, 2$ that are defined with fixed radii r_{ij} pre-determined as per the basic UEG model, the meson shell radius r_{sni} for the synthesized neutral particle at the level i is a variable determined by the mass $m_{i'}$ of the internal charge particle and masses m_{k0} of all levels $i \leq k < i'$. The mass m_{sni} is stable at the radius r_{sni}, determined by having the first derivative of the mass with respect to the radius to be zero and the second derivative positive.

$$\begin{aligned} m_{sn}(r_{i'}, r_i) &= (m_{i'}(r_{i'}) + m_{(i'-1)0} + m_{(i'-2)0} \\ &+ \cdots + m_{i0} - m_i(r_i))/\underline{\epsilon}_{ri}(r_i),\ i' > i, \\ m_{sn}(r_{i'}, r_i) &= (m_{i'}(r_{i'}) - m_i(r_i))/\underline{\epsilon}_{ri}(r_i),\ i' = i, \\ \frac{\partial m_{sn}}{\partial r_i} &= \frac{\partial m_{sn}}{\partial r_{i'}} = 0,\ \frac{\partial^2 m_{sn}}{\partial r_i^2} > 0,\ \frac{\partial^2 m_{sn}}{\partial r_{i'}^2} > 0, \end{aligned} \quad (13)$$

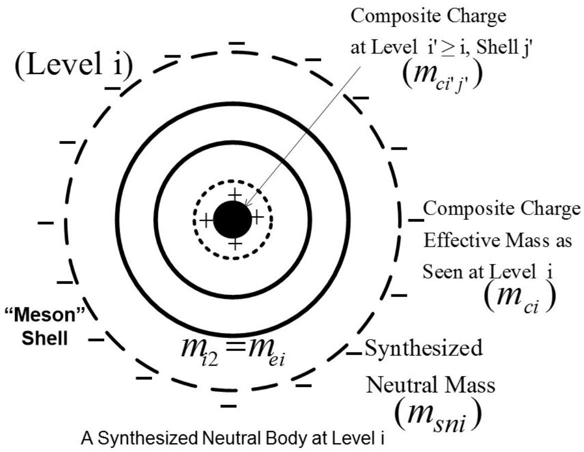


FIG. 6.

$$\begin{aligned} r_{i'} &= r_{i'j'},\ r_i = r_{sni},\ i' \geq i,\ j' = 1, 2, \\ m_{sni} &= \text{Min}[(m_{i'j'} + m_{(i'-1)0} + m_{(i'-2)0} \\ &+ \cdots + m_{i0} - m_i(r_i))/\underline{\epsilon}_{ri}(r_i)]_{r_i = r_{sni}} \\ &= (m_{i'j'} + m_{(i'-1)0} + m_{(i'-2)0} \\ &+ \cdots + m_{i0} - m_i(r_{sni}))/\underline{\epsilon}_{ri}(r_{sni}),\ i' > i, \\ m_{sni} &= \text{Min}[(m_{i'j'} - m_i(r_i))/\underline{\epsilon}_{ri}(r_i)]_{r_i = r_{sni}} \\ &= (m_{i'j'} - m_i(r_{sni}))/\underline{\epsilon}_{ri}(r_{sni}),\ i' = i. \end{aligned} \quad (14)$$

The expression of $m_{sn}(r_{i'}, r_i)$ in (13) is similar in principle to that of $m_{sn}(r_1, r_2)$ in (4), sharing the same basic concepts of the UEG theory [1]. With reference to (13), and Figs.2, 3 [1], for a given $r_{i'}$ the $m_i(r_i)$ increases, and therefore the numerator of m_{sn} reduces, whereas the factor $1/\underline{\epsilon}_{ri}(r_i)$ first remains relatively unchanged but then rapidly increases, as the radius r_i is reduced from $r_i \to \infty$ closer to the central core of the level i $(r_i > r_{i2})$. As we expected, a minimum (stable) value of the $m_{sn} = m_{sni}$ can be clearly established by balancing the two opposing trends indicated above, at a suitable location with $r_i = r_{sni}$ outside of the core region, referred to as the "meson shell".

Note that the standard theoretical value of m_{sni} in (14) needs to be properly scaled using (12), in order to obtain its actual value realized when the external medium is the free space with relative permittivity $\epsilon_{r00} = 1$.

General Neutral Particle of the First Kind, with a Regular or a Composite Charge at an Inner Level:

This is a general treatment for the primary kind of neutral particle discussed above. In this case, the inner level charge in the above model maybe substituted by a general charge with effective mass m_{ci} seen at the level i (see Fig.6), which may be a regular charge, or a general composite charge, in the same or different level. If the inner regular or composite charge is stable or quasi-stable without the external opposite charge, it would also be stable/quasi-stable with the external opposite charge. This should be evident from the formula for the synthesized neutral mass m_{sni}.

$$m_{sn}(r_i) = (m_{ci} - m_i(r_i))/\underline{\epsilon}_{ri}(r_i),\ \frac{\partial m_{sn}}{\partial r_i} = 0,\ \frac{\partial^2 m_{sn}}{\partial r_i^2} > 0,$$
$$r_i = r_{sni},\ m_{sni} = \mathrm{Min}[(m_{ci} - m_i(r_i))/\underline{\epsilon}_{ri}(r_i)]_{r_i = r_{sni}}$$
$$= (m_{ci} - m_i(r_{sni}))/\underline{\epsilon}_r(r_{sni}), \quad (15)$$
$$m_{sni}(\mathrm{actual}) = m_{sni}/(\underline{\epsilon}_{r(i-1)0}\underline{\epsilon}_{r(i-2)0}\cdots\underline{\epsilon}_{r10}(\underline{\epsilon}_{r00} = 1)),$$

$$m_{ci} = m_{ci'j'} + m_{(i'-1)0} + m_{(i'-2)0}\cdots + m_{i0},\ i' > i;$$
$$m_{ci} = m_{ci'j'},\ i' = i;\ j' = 1,2,$$
$$m_{ci} \geq m_{i2} = m_{ei}/2;\ m_{sni} \simeq m_{ci},\ m_{ci} >> m_{ei}. \quad (16)$$

Normalized values for (m_{sni}/m_{ci}) versus $(2m_{ci}/m_{ei}) = (m_{ci}/m_{i2}) \geq 1$ are plotted in Fig.7, that maybe applicable for general use at all levels i. These plots are derived using the normalized functions $m_i(r_i/r_{i2})/m_{i2} = m(r/r_e)/m_e$ and $\underline{\epsilon}_{ri}(r_i/r_{i2}) = \underline{\epsilon}_r(r/r_e)$, which were originally derived from the UEG analysis [1] for the first level $i = 1$, but are assumed to be approximately valid as well for all levels. This is due to primary similarity of the basic UEG model in all levels. In principle, however, the chart in Fig.7 should be separately established with different best-fit data for each different level. This would accommodate secondary differences in the UEG function $\gamma(W_\mathcal{T})$, and in the associated mass $m_i(r_i/r_{i2})$ and inverse-permittivity $\underline{\epsilon}_{ri}(r_i/r_{i2})$ profiles, in the different levels, as well as differences in any inter-level interactions.

However, we will ignore the secondary deviations between the levels, and instead propose to use the same chart of Fig.7 for all levels. This would be accomplished by simply substituting the ideal non-truncated mass m_e in Fig.7 with the effective truncated mass $m_{i2} = W_{i2}/c^2$ from Table V (see section II, Fig.3), without having to introduce additional truncation parameters for each level. Any resulting deficiency in using the common chart of Fig.7, due to the above non-ideal substitution in a given level, appears to be approximately compensated by all the different secondary effects in the level. This would allow uniform use of the Fig.7 for all levels, maintaining the same required trend across the levels, resulting in a simplified mass estimation of any synthesized neutral body of the first kind.

V. NEUTRAL PARTICLE OF THE SECOND KIND, WITH THE EXTERNAL CHARGE PLACED IN A SHELL $j = 1, 2$

A second kind of a neutral charge may be synthesized with oppositely charged bodies placed in different levels i and i'; $i' \geq i$. The charged body in the internal level i' is associated with a shell $j' = 1,2$, as in the first kind of neutral particle (meson, Fig.6) discussed above. However, unlike the first kind of neutral particle, in this case the charge layer in the external level is placed in a conventional shell $j = 1,2$, not in the "meson shell". For a special case, if i' and i maybe the same level, then $j' < j$, which means that the j' is the internal shell whereas j is the external shell of the common level $i' = i$.

The charged body in the internal level i' has two possibilities. In the first group, it is a layer of a standard elementary charge of mass $m_{i'j'}$, located at radius $r_{i'j'}$, with $i' > i$.

$$m_{sn}(r_{i'}, r_i) = [m_{i'}(r_{i'}) + m_{(i'-1)0} + m_{(i'-2)0}$$
$$+ \cdots + m_{i0} - m_i(r_i)]/\underline{\epsilon}_{ri}(r_i),\ i' > i\ ,$$
$$\frac{\partial m_{sn}}{\partial r_{i'}} = \frac{\partial m_{sn}}{\partial r_i} = 0,\ \frac{\partial^2 m_{sn}}{\partial r_{i'}^2} > 0,\ \frac{\partial^2 m_{sn}}{\partial r_i^2} > 0,$$
$$r_{i'} = r_{i'j'},\ r_i = r_{ij},\ i' > i;\ j, j' = 1,2,$$
$$m_{sni} = (m_{i'j'} + m_{(i'-1)0} + m_{(i'-2)0}$$
$$+ \cdots + m_{i0} - m_{ij})/\underline{\epsilon}_{rij}, \quad (17)$$
$$m_{sni}(\mathrm{actual}) = m_{sni}/(\underline{\epsilon}_{r(i-1)0}\underline{\epsilon}_{r(i-2)0}\cdots\underline{\epsilon}_{r10}(\underline{\epsilon}_{r00} = 1)).$$

The expression of $m_{sn}(r_{i'}, r_i)$ in (17) is similar in principle to that of $m_{sn}(r_{i'}, r_i)$ in (13), and of $m_{sn}(r_1, r_2)$ in (4), sharing the same basic concepts of the UEG theory [1].

General Neutral Particle of the Second Kind, with the External Charge Placed in a Shell $j = 1, 2$:

This is the second group of neutral particles of the second kind, following the first group discussed above. This second group is essentially a general treatment of the first group of particles, by replacing the inner charge layer by a composite charge particle of mass $m_{ci'j'}$. If the composite charge is stable/quasi-stable without the external opposite charge, the total neutral charge including the external opposite charge would also be stable/quasi-stable.

$$m_{sn}(r_i) = [m_{ci} - m_i(r_i)]/\underline{\epsilon}_{ri}(r_i),$$
$$m_{ci} = m_{ci'j'},\ i' = i;$$
$$m_{ci} = m_{ci'j'} + m_{(i'-1)0} + m_{(i'-2)0}$$
$$+ \cdots + m_{i0},\ i' > i;\ j' = 1,2,$$
$$\frac{\partial m_{sn}}{\partial r_i} = 0,\ \frac{\partial^2 m_{sn}}{\partial r_i^2} > 0;\ r_i = r_{ij},\ j = 1,2;$$
$$m_{sni} = (m_{ci} - m_{ij})/\underline{\epsilon}_{rij}, \quad (18)$$
$$m_{sni}(\mathrm{actual}) = m_{sni}/(\underline{\epsilon}_{r(i-1)0}\underline{\epsilon}_{r(i-2)0}\cdots\underline{\epsilon}_{r10}(\underline{\epsilon}_{r00} = 1)).$$

VI. COMPOSITE CHARGED PARTICLES

A composite charged particle consists of an elementary charge layer at a radius $r = r_{ij}$, at a particular level i

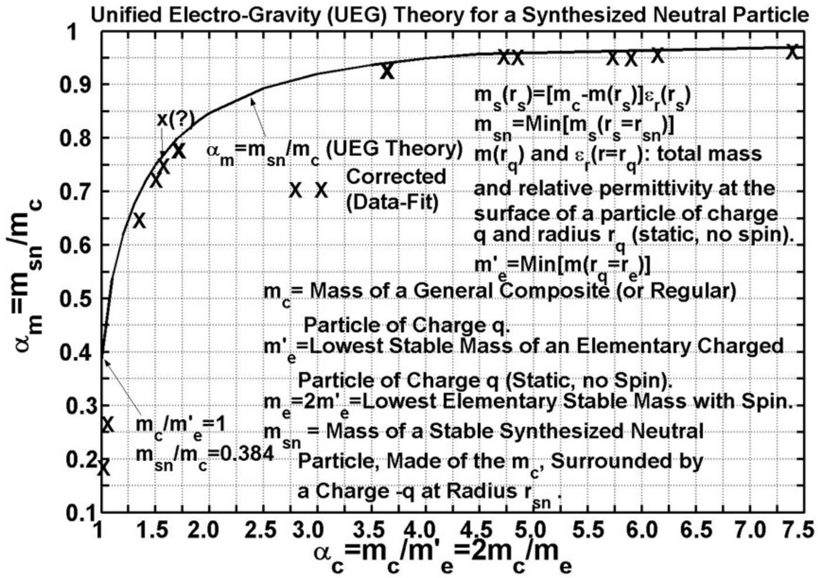


FIG. 7.

and shell j, together with a synthesized neutral particle placed internal to this charged layer at level i'. The mass or energy of the total particle is quasi-stable at the radius r, defined by the derivative of the mass with the r to be zero, whereas the second derivative may be positive or negative for the part of the mass contributed by the external charge layer or the internal synthesized neutral body, respectively. Due to the quasi-stable nature of the particle, the particle is associated with a transient state that would naturally decay to other particles of lower mass. The mass m_{cij} of such a composite particle may be expressed in terms of the mass m_{ij} of an elementary charge particle at the particular level and shell (ij), with radius r_{ij}, and the mass $m_{sni'}$ of the synthesized neutral particle at the level i' (see Fig.8). The level i' is normally greater than the level i, but it maybe at the same level as i if the synthesized neutral particle is of the second kind (see section V), and the shell j' of the outermost charge layer of the synthesized neutral particle is internal to the shell j $(j' < j)$.

$$\begin{gathered} m_{ci}(r) = m_i(r) + m_{sni'}\epsilon_{ri}(r),\ i' = i; \\ m_{ci}(r) = m_i(r) + \\ m_{sni'}\epsilon_{ri}(r)/(\epsilon_{r(i'-1)0}\epsilon_{r(i'-2)0}\cdots\epsilon_{ri0}),\ i' > i; \\ \frac{\partial m_{ci}}{\partial r} = 0,\ \frac{\partial m_i}{\partial r} = 0,\ \frac{\partial^2 m_i}{\partial r^2} > 0, \\ \frac{\partial \epsilon_{ri}}{\partial r} = 0,\ \frac{\partial^2 \epsilon_{ri}}{\partial r^2} < 0, \end{gathered} \tag{19}$$

$$\begin{gathered} r = r_{ij},\ m_{cij} = m_{ij} + m_{sni'}\epsilon_{rij},\ i' = i; \\ m_{cij} = m_{ij} + \\ m_{sni'}\epsilon_{rij}/(\epsilon_{r(i'-1)0}\epsilon_{r(i'-2)0}\cdots\epsilon_{ri0}),\ i' > i. \end{gathered} \tag{20}$$

It may be noted that, for notational and formulational convenience, the mass m_{ij} or m_{cij}, respectively of an elementary or a composite charged particle at a given level i, refers to only a theoretical number which is the contribution of mass at the given level i and internal to the level. The actual mass, if there is no other charge layer external to the level i, would be equal to this reference theoretical mass plus sum of masses m_{k0} associated with all levels $k < i$.

$$\begin{gathered} m_{cij}(\text{actual}) = m_{cij},\ i = 1; \\ m_{cij}(\text{actual}) = m_{cij} + \\ m_{(i-1)0} + m_{(i-2)0} + \cdots + m_{10},\ i > 1. \end{gathered} \tag{21}$$

VII. CALCULATIONS FOR KNOWN PARTICLES USING THE GENERALIZED UEG THEORY

We will apply the generalized UEG theory that we have developed to known particles (leptons, baryons and mesons), and compare the resulting mass/energy estimates from the UEG theory to best available measured values [2–4]. The generalized UEG models in sections III-VI are based on a stair-case approximation of the UEG constant γ in section II for different regions of energy density (see Fig.1), and also assume that the total mass including spin is twice that of the static UEG mass. This ignores any higher-order effects in a rigorous UEG theory, that would require a variable γ having a smooth functional dependence on the energy density, as well as in a rigorous spin model based on a dynamic UEGM (Unified Electro-Gravito-Magnetic) theory that would be valid for simple as well as composite particles. The rigorous models can be significantly more complicated to compute, and may at this point be pre-mature to establish accurately.

However, the effects of the rigorous models, presumably small over a simplified (first order) general UEG model, may be accounted for by introducing reasonable corrections to various key parameters obtained from the simple UEG theory. The corrected parameters are listed in Table V, and are estimated by fitting the simple UEG theory for selected particles to match their measured mass/energy, as shown in Appendix. The corresponding parameters obtained from a simple UEG theory are also listed alongside the corrected values in Table V for comparison. The simple and the corrected parameters are seen to maintain certain relative trends from shell to shell in a given particle level, which may imply that the same general foundation is shared by the simple and the rigorous models, except with reasonable numerical adjustments in the parameter values due to higher-order effects.

These adjusted parameters from Table V are then used in a simple UEG theory, by employing the synthesis rules of sections II-VI, to estimate the mass of all leptons (Table I), and all principal baryons (Table II) and mesons (Table III), and the resulting mass estimates are compared to available measured data [2–4]. Possible UEG configurations that may emulate other basic particles (Higgs Boson [13–15], W and Z bosons [16, 17], Top [18–20] and Bottom [21, 22] quarks) that have been experimentally observed are also listed in Table IV. Note that the Top and Bottom quarks are modeled in the Table IV as equivalent neutral, boson-like particles, which might be detected in pairs that transitionally represent the respective quark-antiquark combinations. Close agreements between the masses estimated using the UEG theory and available measured data in Tables I-IV for such a large class of basic and composite particles clearly suggests the power of the new UEG theory as a potential substitute for the Standard Model of particle physics.

It maybe noted, that the spin states assumed for the particles in Tables I-IV, based on the UEG model, may not always match with the expected spin states of the corresponding particles identified from the Standard Model. The correspondence is made based principally on the particles' charge and mass/energy. That maybe fine, considering that the spin states are often difficult to confirm from measurement, and in such cases they might have been identified in the Standard Model simply based on the model's (mistaken) theoretical expectations. The measured spin state of a particle, that is based on the spin states of only identified decay products of the particle, might be easily mis-characterized as a meson (boson) instead of a fermion, or vice versa, particularly if a spin-1/2 decay element is missing or improperly detected (a neutrino, for example).

VIII. CONCLUSION

The basic UEG theory, first developed to model an electron [1] and then separately validated through quantum mechanics [7], is proposed to be generalized in this paper to model all basic and composite particles [2–4] covered by the standard model of particle physics. A general structural configuration for a particle, and the associated theoretical and calculation rules to synthesize any such general particle, are proposed and successfully applied to model and predict the masses of a large class of basic and composite particles, including some "force carriers".

The purpose of the proposed particle configurations and the resulting mass estimates based on the new UEG theory, for such a large class of known particles, is not to focus on any definite study of the individual particles. In fact, it should be reasonable to expect that the actual configurations and mass estimates may deviate somewhat or significantly from those proposed here, almost certainly for a handful of the large number of particles studied. The real purpose is to provide a new theoretical paradigm for particle physics, that is convincingly shown here to have the capacity to model a large class of, possibly all, known basic and composite particles. The clear success of this exercise is a remarkable scientific development. It establishes that the new UEG theory, which obviously unifies the electromagnetic and gravitational theories in explicit terms, could also unify the entire standard model of particle physics [5, 6] under its general scope, thus making the strong and weak forces, as well as all classification schemes of elementary particles (leptons, quarks and force carriers), of the standard model physically redundant. Accordingly, a rigorous version of the new UEG theory may provide a definite physical basis for a grand-unified theory (GUT) [23, 24] and a theory of everything (ToE) [25], which have been the grand aspiration of modern physics in recent decades.

Appendix: Estimation of Parameters of the Unified Electro-Gravity (UEG) Theory, Using Available Energy Data of Known Particles

Refer to the UEG synthesis rules for different particles (see sections II-VI). Tables I-IV show the charge structures for all basic and composite particles, synthesized using the UEG theory. The mass/energy formulas associated in the synthesis of the different particles are not explicitly shown, but should be self-evident in the following calculations. For reference, see Table-I for an example calculation of such synthesis.

(1) Electron (e), Proton (p) and Neutron (n), masses determine the energies for levels 1 and 2 :

$$m_e = W_{12} \approx W_{11} \approx W_{10} = 0.5MeV$$
$$m_p = W_{22} = 938.3MeV$$
$$m_n = W_{21} \approx W_{20} = 939.6MeV$$

(2) Use m_μ, $m_{\pi\pm}$, m_η data to calculate ε_{r12} and ε_{r11} :

$$\varepsilon_{r11} = m_\mu/m_\eta = 105.7/547.8 = 0.193$$
$$\varepsilon_{r12}/\varepsilon_{r11} = m_{\pi\pm}/m_\mu = 139.6/105.7 = 1.32$$
$$\varepsilon_{r12} = 0.193 \times 1.32 = 0.255$$

(3) Use $m_{\Lambda+}$, $m_{\Xi'c+}$, ε_{r11} to calculate ε_{r10} :

$$\varepsilon_{r11}/\varepsilon_{r10} > m_{\Xi'c+}/m_{\Lambda+} = 2576/2286 = 1.127$$
$$\varepsilon_{r10} < \varepsilon_{r11}/1.127 = 0.193/1.127 = 0.171$$
$$m_{c2} = m_{\Lambda+} = 2286,\ m'_{e2} = m_p/2$$
$$\alpha_{c2} = m_{c2}/m'_{e2} = m_{\Lambda+}/(m_p/2)$$
$$= 2286/(938.3/2) = 4.87$$
$$\alpha_{m2} = 0.95 \text{ (from chart)}$$
$$m_{sn2} = m_{c2} \times \alpha_{m2} = 2286 \times 0.95 = 2171.7$$
$$\varepsilon_{r11}/\varepsilon_{r10} = m_{\Xi'c+}/m_{sn2} = 2576/2171.7 = 1.186$$
$$\varepsilon_{r10} = \varepsilon_{r11}/1.186 = 0.193/1.186 = 0.162$$

(4) $\Lambda+$ and $W_{20} = m_n$ energies determine W_{31} :

$$W_{31} = m_{\Lambda+} - W_{20}/2 = 2286 - 939.6/2 = 1816.2$$

(5) $\Xi'c+$, $\Xi c+$ and W_{31} energies determine W_{32}. This assumes that the meson factors α_{m2} for both $\Xi'c+$, $\Xi c+$ are approximately the same, because the respective meson mass coefficients α_{c2} are expected to be very close:

$$m_{\Xi'c+}/m_{\Xi c+} = W_{31}/W_{32} = 2576/2467 = 1.044$$
$$W_{32} = W_{31}/1.044 = 1816.2/1.044 = 1739.7$$

(6) Muon mass determines the meson factor $\alpha_{m2} = m_{sn2}/m_{c2}$ for $\alpha_{c2} = m_{c2}/m'_{e2} = m_{c2}/(W_{22}/2) = 1$, $m_{c2} = W_{22}/2$, in level $i = 2$. The result would be valid for all levels i :

$$\alpha_{m2} = m_{sn2}/m_{c2} = W_{sn22}/(W_{22}/2)$$
$$= 105.7 \times (\varepsilon_{r10}/\varepsilon_{r11})/(938.3/2)$$
$$= 105.7 \times 0.162/0.193/(938.3/2) = 0.189$$
$$= W_{sni2}/(W_{i2}/2) = \alpha_{mi2}, \text{ for all i.}$$

(7) Use Ξ_- energy, and W_{31} from result (4), ε_{r20} from result (8b) below, and the factor α_{m31} (see the end note), to get ε_{r22} :

$$m_{\Xi-} - m_{e2} = 1321 - 938.3 = 382.7 = W_{sn31} \times (\varepsilon_{r22}/\varepsilon_{r20})$$
$$= \alpha_{m31} \times (W_{31}/2) \times (\varepsilon_{r22}/\varepsilon_{r20})$$
$$= 0.269 \times 1816.2/2 \times (\varepsilon_{r22}/0.110)$$
$$\varepsilon_{r22} = 382.7 \times 0.11 \times 2/0.269/1816.2 = 0.172$$

(8a) Use $\Lambda 0$, W_{32} energies and the ratio $\alpha_{m3} = W_{sn32}/W_{32} = 0.189/2 = 0.0945$ from result (6) to get the ratio $\varepsilon_{21}/\varepsilon_{20}$:

$$m_{\Lambda 0} - m_n = 1115 - 939.6 = 175.4 = W_{sn32} \times (\varepsilon_{r21}/\varepsilon_{r20})$$
$$= 0.0945 \times W_{32} \times (\varepsilon_{r21}/\varepsilon_{r20}) = 0.0945 \times 1740 \times (\varepsilon_{r21}/\varepsilon_{r20})$$
$$\varepsilon_{r20}/\varepsilon_{r21} = 1740 \times 0.0945/175.4 = 0.937$$

(8b) Use Tauon energy, and results from (2), (3) and (8a) to calculate ε_{r21} and ε_{r20} :

$$m_\tau \times (\varepsilon_{r10}/\varepsilon_{r11}) = 1776 \times 0.162/0.193 = 1490.74$$
$$= W_{sn32}/\varepsilon_{r20} = 0.0945 \times 1740/\varepsilon_{r20}$$
$$\varepsilon_{r20} = 0.0945 \times 1740/1490.74 = 0.110$$
$$\varepsilon_{r21} = \varepsilon_{r20}/(\varepsilon_{r20}/\varepsilon_{r21}) = 0.110/0.937 = 0.117$$

(9) $\Lambda 0b$, $\Sigma b+$, W_{21}, and W_{31} energies determine the energies of level $i = 4$:

$$W_{42} = m_{\Lambda 0b} - (W_{20}/2) - (W_{30}/2)$$
$$= 5620 - (939.6/2) - (1816/2) = 4242.1$$
$$W_{41} \approx W_{40} = m_{\Sigma b+} - (W_{20}/2) - (W_{30}/2)$$
$$= 5807 - (939.6/2) - (1816/2) = 4429.1$$

(10) Use Ξb, W_{20}, W_{42} energies and results from (2), (3), (6) and (8) to get ε_{r30} :

$$[m_{\Xi b-} \times (\varepsilon_{r10}/\varepsilon_{r11}) - (W_{20}/2)] \times (\varepsilon_{r20}/\varepsilon_{r21})$$
$$= [5790 \times (0.162/0.193) - (939.8/2)] \times (0.11/0.117)$$
$$= 4390.2 \times 0.937 = 4113.6 = W_{sn42}/\varepsilon_{r30}$$
$$= (W_{42}/2) \times 0.189/\varepsilon_{r30} = 4242 \times 0.0945/\varepsilon_{r30}$$
$$\varepsilon_{r30} = 4242 \times 0.0945/4113.6 = 0.097$$

The above result assumes $\alpha_{m2} \approx 1$. This can now be verified to be correct, because in this case we have $\alpha_{c2} = (4390.2 + (939.6/2))/(938.3/2) = 10.4 >> 1$.

(11) Use ηc, W_{21}, W_{22}, W_{31}, W_{42} energies and results from (2), (3), (6), (8) and (10) to estimate ε_{r31}, which would best-fit with the ($\alpha_m \sim \alpha_c$) meson-factor chart (Fig.7):

Increasing ε_{r31} would increase meson coefficient α_c and meson factor α_m, and accordingly the particle mass. We assume that $\varepsilon_{r31} \geq \varepsilon_{r30} = 0.097$. Try first the lowest value for $\varepsilon_{r31} = \varepsilon_{r30} = 0.097$:

$$\mathrm{m}_{\eta c} = (\mathrm{W}_{42}/2 \times \alpha_{\mathrm{m4}} \times (\varepsilon_{r31}/\varepsilon_{r30}) + \mathrm{W}_{31} + \mathrm{W}_{21}/2)$$
$$\times \alpha_{\mathrm{m2}} \times (\varepsilon_{r11}/\varepsilon_{r10}) = (4242/2 \times 0.189 \times (0.097/0.097)$$
$$+ 1816 + 939.6/2) \times 0.95 \times (0.193/0.162) = 3041\mathrm{MeV};$$
$$\alpha_{c2} = ((4242/2 \times 0.189 \times (0.097/0.097) + 1816$$
$$+ 939.6/2)/(\mathrm{W}_{22}/2) = 5.73,\ \alpha_{\mathrm{m2}} = 0.95 \text{ (from chart)}.$$

The above calculated mass is reasonably close to the available data for the particle mass $m_{\eta c}$=2980MeV,

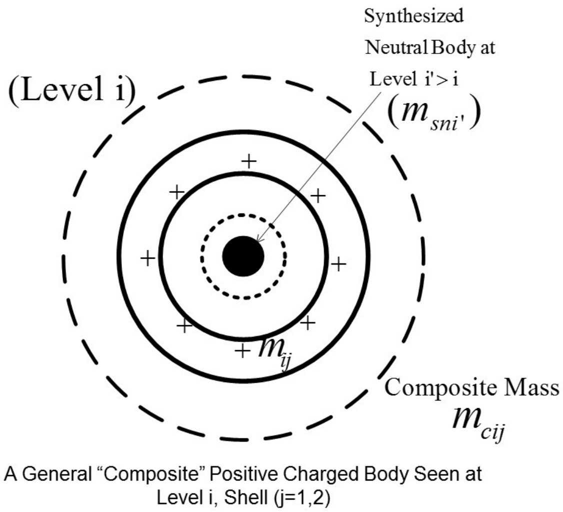


FIG. 8.

within about a few percent accuracy. Note that the calculation is already larger than the available mass data. Any increase of ε_{r31} would increase the particle mass and increase the deviation from the mass data. Therefore, the best estimate for ε_{r31} is equal to $\varepsilon_{r30} = 0.097$.

(12) Use $B\pm$, W_{21}, W_{22}, W_{32}, W_{41}, W_{42} energies and results from (2), (3) and (10) to estimate ε_{r32}, which would best fit with the $(\alpha_m \sim \alpha_c)$ meson-factor chart (Fig.7):

$$\mathrm{m}_{B\pm} = (\mathrm{W}_{41}/2 \times \alpha_{\mathrm{m}4} \times (\varepsilon_{\mathrm{r}32}/\varepsilon_{r30}) + \mathrm{W}_{32} + \mathrm{W}_{21}/2) \times \alpha_{\mathrm{m}2} \times (\varepsilon_{\mathrm{r}21}/\varepsilon_{r10}) = (4429/2 \times 0.269 \times (\varepsilon_{\mathrm{r}32}/0.097) + 1740 + 939.6/2) \times \alpha_{\mathrm{m}2} \times (0.255/0.162) = 5279\mathrm{MeV};$$

$$\alpha_{c4} = (4429/2)/(\mathrm{W}_{42}/2) = (4429/2)/(4242/2) = 1.044,$$

$$\alpha_{\mathrm{m}4} = 0.269\,(\text{from chart})$$

$$\alpha_{c2} = (4429/2 \times 0.269 \times (\varepsilon_{\mathrm{r}32}/0.097) + 1740 + 939.6/2) /(\mathrm{W}_{22}/2) = (6141.24 \times \varepsilon_{\mathrm{r}32} + 2209.8)/(938.3/2)$$

A bit of trial iterations would be needed in the above calculations to get solution for ε_{r32}=0.206, $\alpha_{c2} = 7.407$, $\alpha_{m2} = 0.965$ (from the chart, Fig.7).

Note: $\alpha_{ci} = m_{ci}/m'_{ei} = m_{ci}/(W_{i2}/2) \approx 1.044$ for $m_{ci} = W_{i1}/2$, for $i = 3$ and 4. That is, $W_{31}/W_{32} = 1740/1816 \approx W_{41}/W_{42} = 4429/4242 = 1.044$. Therefore, the corresponding $\alpha_{mi} = m_{sni}/m_{ci} = W_{sni1}/(W_{i2}/2)$ would be same. For this value of $\alpha_{ci} = 1.044$, α_{mi} is estimated to be 0.269, which best fit all particle data consistent with the UEG theory. Accordingly, we will use $W_{sni1}/(W_{i2}/2) = 0.269 = \alpha_{mi1}$ for $i = 3$, 4, for all calculations.

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Table I

UEG Shell Model of Baryons

Name	Energy	Energy (Est)	Level One Configuration			Level Two Configuration			Level Three Configuration			Level Four Configuration		
	(MeV)	(MeV)	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1
p	938.3	938.3					+							
n	939.6	939.6	—					+						
$\Lambda\ 0$	1115	1114.5	—					+	—	+				
$\Lambda\ +$	2286	2285.8									+			
$\Lambda 0b$	5620	5619.8	— —										+	
$\Sigma\ +$	1189	1199.4						+	—		+			
$\Sigma\ 0$	1192	1199.4	—					+	—		+			
$\Sigma\ -$	1197	1199.4						—	+		—			
$\Sigma c{+}{+}(?)$	2454													
$\Sigma c+$	2453	2353		+					—	+				
$\Sigma c0$	2454	2353	—	+					—	+				
$\Sigma b+$	5807	5806.8												+
$\Sigma b0$		5806.8	—											+
$\Sigma b-$	5815	5806.8												—
$\Xi\ 0$	1314	1320.2	—				+		—		+			
$\Xi\ -$	1321	1320.2					—		+		—			
$\Xi c+$	2467	2501			+	—				+				
$\Xi c0$	2470	2501	—		+	—				+				
$\Xi c+'$	2576	2587			+	—					+			
$\Xi c0'$	2578	2587	—		+	—					+			
$\Xi cc{+}{+}(?)$														
$\Xi cc+$	3518	3495.2		+					—		+			
$\Xi b0$		5796.5	—		+	—		+				—	+	
$\Xi b-$	5790	5796.5			—	+		—				+	—	
$\Omega c0$	2695	2645.4	—		+				—		+			
$\Omega b-$	6165	6143						—	+				—	
$\Lambda\ +$	1232							+	+	—				
$\Sigma\ +$	1383							+	+		—			
$\Sigma\ 0$	1384		—					+	+		—			
$\Sigma\ -$	1387							—	—		+			
$\Sigma c+$	2517			+					+	—				
$\Sigma c0$	2518		—	+					+	—				
$\Xi\ 0$	1531		—				+		+		—			
$\Xi\ -$	1535						—		—		+			

Lower block for selected J=3/2 baryons as examples. Top block for regular J=1/2 baryons.

Compare J=3/2 baryons with corresponding J=1/2 baryons, in terms of their relative charge structure.

They are different equivalent charge states of the same composite structure. Although the two charge states are equivalent electrically, but with spinning they lead to different (magnetically) dynamic states, having somewhat differeent energy/mass.

Name	Energy	Energy (Est)	Calculations
	(MeV)	(MeV)	
p	938.3	938.3	
n	939.6	939.6	
$\Lambda\ 0$	1115	1114.5	1740/2*0.189*0.117/0.11+939.6=1114.5. Meson factor: 0.189, Level 3.
$\Lambda\ +$	2286	2285.8	1816+939.6/2=2285.8
$\Lambda 0b$	5620	5619.8	4242+1816/2+939.8/2=5619.8
$\Sigma\ +$	1189	1199.4	1816/2*0.269*0.117/0.11+939.6=1199.4. Meson factor: 0.269, Level 3.
$\Sigma\ 0$	1192	1199.4	
$\Sigma\ -$	1197	1199.4	
$\Sigma c{+}{+}(?)$	2454		
$\Sigma c+$	2453	2353	1740/2*0.189/0.11*0.255/0.162=2353. Meson factor: 0.189, Level 3.
$\Sigma c0$	2454	2353	
$\Sigma b+$	5807	5806.8	4429+1816/2+939.6/2=5806.8
$\Sigma b0$		5806.8	
$\Sigma b-$	5815	5806.8	
$\Xi\ 0$	1314	1320.2	1816/2*0.269*0.172/0.11+938.3=1320.2. Meson factor: 0.269, Level 3.
$\Xi\ -$	1321	1320.2	
$\Xi c+$	2467	2501	(1740+939.6/2)*0.95*0.193/0.162=2501. Meson factor: 0.95 (alpha_c=4.71), Level 2.
$\Xi c0$	2470	2501	
$\Xi c+'$	2576	2587	(1816+939.6/2)*0.95*0.193/0.162=2587. Meson factor: 0.95 (alpha_c=4.87), Level 2.
$\Xi c0'$	2578	2587	
$\Xi cc{+}{+}(?)$			
$\Xi cc+$	3518	3495.2	1816/2*0.269/0.11*0.255/0.162=3495.2. Meson factor: 0.269, Level 3.
$\Xi b0$		5796.5	(4242/2*0.189/0.097*0.117/0.11+939.6/2)*(1.0)*0.193/0.162=5796.5. Meson factors: 1.0 (alpha_c=10.37), Level 2;
			0.189, Level 4.
$\Xi b-$	5790	5796.5	
$\Omega c0$	2695	2645.4	1816/2*0.269/0.11*0.193/0.162=2645.4. Meson factor: 0.269, Level 3.
$\Omega b-$	6165	6143	(4242+1816/2)*0.95*0.117/0.11+939.6=. Meson factor: 0.95 (alpha_c=5.92), Level 3.
$\Lambda\ +$	1232		
$\Sigma\ +$	1383		
$\Sigma\ 0$	1384		
$\Sigma\ -$	1387		
$\Sigma c+$	2517		
$\Sigma c0$	2518		
$\Xi\ 0$	1531		
$\Xi\ -$	1535		

Refer to the UEG synthesis rules for different particles (sections II-VI). The mass/energy formula associated in the synthesis of a particular particle maybe evident from its calculation shown above. For example, the specific calculations for the particle $(\Xi 0)$ are explained in the following:

Step 1: Neutral Particle of Kind 1, at level 3 (see section IV):
$m_{31} = W_{31}/2 = 1816/2$ MeV (Table V), $m'_{e3} = W_{32}/2 = 1740/2$ MeV (Table V),
$\alpha_c = m_{31}/m'_{e3} = m_c/m'_{e3} = 1.044$, $\alpha_m = 0.269 = \alpha_{mi1}$ (Table V, Fig.7),
$m_{sn3} = \alpha_m m_c = \alpha_{mi1} m_{31} = 1816/2*0.269$ MeV

Step 2: Composite Charge Particle, at level 2 (see section VI):
$m_{22} = W_{22} = 938.3$ MeV (Table V, assume full mass with spin for the level 2),
$\varepsilon_{r22} = 0.172$, $\varepsilon_{r20} = 0.11$ (Table V),
$m_{c2} = m_{22} + [m_{sn3}/\varepsilon_{r20}]\varepsilon_{r22} = 1816/2*0.269*0.172/0.11$ MeV.

Step 3: Neutral Particle of Kind 1, at level 1 (see section IV):
$m_c = m_{c2}$, $m'_{e1} = W_{12}/2 = 0.5/2$ MeV (Table V),
$\alpha_c = m_c/m'_{e1} >> 1$, $\alpha_m \simeq 1$ (Fig.7),
$m_{sn1} = \alpha_m m_c \simeq m_c = m_{c2} = 1816/2*0.269*0.172/0.11$ MeV=1320.2 MeV=mass of the particle Ξ_0.
(Notice that this last step is a trivial approximation. Such a trivial approximate step for synthesis of a neutral particle at the level 1 may not be explicitly shown in the above calculations table.)

Table II

UEG Shell Model of Mesons

Name	Energy	Energy (Est.)	Level One Configuration			Level Two Configuration			Level Three Configuration			Level Four Configuration		
	(MeV)	(MeV)	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1
$\pi +$	139.6	139.6		+		−	+							
$\pi -$	139.6	139.6		−		+	−							
$\pi\ 0$	135	139.6	−	+		−	+							
η	547.8	547.3				−	+							
$\eta\ '$	957.8	937	−	+		−	+		−	+				
$\eta\ c$	2980	3041	−		+	−					+	−	+	
$\eta\ b$	9390	9227							−	+				
$K +$	493.7	495.4			+	−		+	−	+				
$K -$	493.7	495.4			−	+		−	+	−				
$K\ 0$	497.6	495.4	−		+	−		+	−	+				
$D +$	1869	1883			+	−		+	−		+	−		+
$D -$	1869	1883			−	+		−	+		−	+		−
$D\ 0$	1864	1883	−		+	−		+	−		+	−		+
$Ds+$	1968	1942						+	−		+	−	+	
$Ds-$	1968	1942						−	+		−	+	−	
$B +$	5279	5278		+		−				+		−		+
$B -$	5279	5278		−		+				−		+		−
$B\ 0$	5279	5278	−	+		−				+		−		+
$B0s$	5366	5335	−					+				−	+	
$Bc+$	6277	6349						+	−					+
$Bc-$	6277	6349						−	+					−
$\rho\ +$	775			+		+	−							
$\rho\ -$	775			−		−	+							
$\rho\ 0$	775		−	+		−	−							

$\rho+/-/0$ are shown as examples of vector mesons, all others are pseudo-scalar mesons.
Compare $\rho+/-/0$ mesons with corresponding scalar mesons $\pi+/-/0$ in terms of their relative charge structure.
Vector mesons are different composite charge states of the corresponding pseudo-scalar mesons. Although the two charge states are essentially equivalent electrically, with spinning they lead to slightly, magnetically different dynamic states.

Name	Energy	Energy (Est.)	Calculations
	(MeV)	(MeV)	
$\pi +$	139.6	139.6	938.3/2*0.189*0.255/0.162=139.6MeV. Meson factor: 0.189, Level 2.
$\pi -$	139.6	139.6	
$\pi\ 0$	135	<139.6	Meson factors: <1, Level 1; 0.189, Level 2.
η	547.8	547.3	938.3/2*0.189/0.162=547.3MeV. Meson factor: 0.189, Level 2.
$\eta\ '$	957.8	937	(1740/2*0.189*0.172/0.11+(938.3/2.0))*0.82*0.255/0.162=937. Meson factors: 0.837 (alpha_c=1.547), Level 2; 0.189, Level 3.
$\eta\ c$	2980	3041	(4242/2*0.189*0.097/0.097+1816+939.6/2)*0.95*0.193/0.162=3041MeV. Meson facors: 0.95 (alpha_c=5.73), Level 2; 0.189, Level 4.
$\eta\ b$	9390	9227	1740/2*0.189/0.11/0.162=9227MeV. Meson factor: 0.189, Level 3.
$K +$	493.7	495.4	(1740/2*0.189*0.117/0.11+939.6/2)*0.645*0.193/0.162=495.4. Meson factors: 0.645 (alpha_c=1.374), Level 2; 0.189, Level 3.
$K -$	493.7	495.4	
$K\ 0$	497.6	495.4	
$D +$	1869	1883	((4429/2*0.269*0.097/0.097+1816/2)*(0.775)*0.117/0.11+939.6)*(0.925)*0.193/0.162=1883MeV.
$D -$	1869	1883	Meson factors: 0.925 (alpha_c=3.64); 0.775 (alpha_c=1.728), Level 3; 0.269, Level 4.
$D\ 0$	1864	1883	
$Ds+$	1968	1942	((4242/2*0.189*0.097/0.097+1816/2)*0.72)*0.117/0.11+939.6=1942MeV. Meson factors: 0.72 (alpha_c=1.504), Level 3;
$Ds-$	1968	1942	0.189, Level 4.
$B +$	5279	5278	(4429/2*0.269*0.206/0.097+1740+939.6/2)*(0.965)*0.255/0.162=5278MeV; Meson factors: 0.965 (alpha_c=7.407), Level 2;
$B -$	5279	5278	0.269, Level 4.
$B\ 0$	5279	5278	
$B0s$	5366	5335	4242/2*0.189/0.097*0.117/0.11+939.6=5335MeV. Meson factor: 0.189, Level 4.
$Bc+$	6277	6349	(4429+1816/2)*0.953*0.117/0.11+939.6=6349 Meson factor: 0.953 (alpha_c=6.13), Level 3.
$Bc-$	6277	6349	
$\rho\ +$	775		
$\rho\ -$	775		
$\rho\ 0$	775		

Refer to the UEG synthesis rules for different particles (sections II-VI). The mass/energy formula associated in the synthesis of a particular particle maybe evident from its calculation shown above. See Table-I for an example of such synthesis.

Table III

UEG Shell Model of Leptons

Name	Energy	Energy(Est.)	Level One Configuration			Level Two Configuration			Level Three Configuration			Level Four Configuration		
	(MeV)	(MeV)	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1
$e+$	0.5	0.5		+										
$e-$	0.5	0.5		−										
e/ν	<0.000005	<0.00005		− +										
$\mu+$	105.7	105.6			+	−	+							
$\mu-$	105.7	105.6			−	+	−							
μ/ν	<0.17	<0.57					− +							
		0.0473	−	+										
$\tau+$	1776	1780			+				−	+				
$\tau-$	1776	1780			−				+	−				
τ/ν	<15.5	<9.8								− +				

Note: For neutrinos, both charges are close to each other in the same shell, either shell #1 or #2, placed near one of the locations where permittivity is infinity

Name	Energy	Energy (Est.)	Calculations
	(MeV)	(MeV)	
$e+$	0.5	0.5	UEG parameter γ_1 for level 1 determines the electron/positron energy.
$e-$	0.5	0.5	
e/ν	<0.000005	<0.00005	< 0.5*0.0001=0.00005MeV; Assume neutrino factor <0.0001.
$\mu+$	105.7	105.6	938.3/2*0.189*0.193/0.162=105.6MeV. Meson Factor: 0.189, Level 2.
$\mu-$	105.7	105.6	
μ/ν	<0.17	<0.57	<938.3*0.0001/0.162=0.57MeV; Neutrino factor < 0.0001.
		0.0473	0.5/2*0.189=0.0473MeV; Meson Factor: 0.189, Levcel 1.
$\tau+$	1776	1780	1740/2*0.189/0.11*0.193/0.162=1780MeV. Meson factor: 0.189, Level 3.
$\tau-$	1776	1780	
τ/ν	<15.5	<9.8	<1740*0.0001/0.11/0.162=9.8MeV; Neutrino factor<0.0001.

Refer to the UEG synthesis rules for different particles (sections II-VI). The mass/energy formula associated in the synthesis of a particular particle maybe evident from its calculation shown above. See Table-I for an example of such synthesis.

Table IV

UEG Shell Model of Special Particles

(W, Z and H Bosons, Top (t) and Bottom (b) Quarks)

Name	Energy	Energy(Est.)	Level One Configuration			Level Two Configuration			Level Three Configuration			Level Four Configuration		
	(GeV)	(GeV)	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1	Meson Shell	Shell 2	Shell 1
$W+$	80.39	75.3			+		−			+	−			+
		87.9		+								−		+
		82.6		+				− +				−		+
$W-$	80.39	82.6(81.9)		−				− +				−		+
Z	91.19	92.1					−			+				
H	125.09	127.2						−			+	−		+
$(t^{+}+t^{-})/2$	173.21	175.5		−	+							−	+	
$(b^{+}+b^{-})/2$	4.18	4.51		−				+	−	+				

Name	Energy	Energy (Est.)	Calculations
	(GeV)	(GeV)	
$W+$	80.39	75.3	(4.429/0.097*0.2+1.740)/0.172/0.162*0.193=75.3GeV
		87.9	(4.429/2*0.269)/(0.162*0.11*0.097)*0.255=87.9GeV. Meson factor: 0.269, Level 4.
		82.6	(4.429/2*0.269)/0.097/0.11*(0.11/0.117)/0.162*0.255=82.6GeV. Similar to above. Level 2 (special 0th shell and shell 1 used).
$W-$	80.39	82.6(81.9)	(75.3+87.9+82.6)/3=81.9GeV. W+, but level 1 charge negative. One state shown, average of three states (=81.9GeV) listed.
Z	91.19	92.1	(1.740+(4.242/2*0.189)*0.2/0.097)/.172/.162=92.1GeV. Meson factor: 0.189, Level 4.
H	125.09	127	(4.429/2.0*0.269/0.097*0.097+1.816+0.939.6-0.939.6)/0.117/0.162=127.2GeV. Meson factor: 0.269, Level 4.
$(t^{+}+t^{-})/2$	173.21	175.5	4.242/2.0*0.189/0.097/0.11/0.162*0.193/0.255=175.5GeV. Meson factor: 0.189, Level 4.
$(b^{+}+b^{-})/2$	4.18	4.37	(1.740/2.0*0.189*0.117/0.11+0.9396)/0.255=4.37GeV. Meson factor: 0.189, Level 3.

Refer to the UEG synthesis rules for different particles (sections II-VI). The mass/energy formula associated in the synthesis of a particular particle maybe evident from its calculation shown above. See Table-I for an example of such synthesis.

Table V
UEG Parameters For Particle Modeling

	Level One Parameters			Level Two Parameters			Level Three Parameters			Level Four Parameters		
	$1/\varepsilon_{r12}$	$1/\varepsilon_{r11}$	$1/\varepsilon_{r10}$	$1/\varepsilon_{r22}$	$1/\varepsilon_{r21}$	$1/\varepsilon_{r20}$	$1/\varepsilon_{r32}$	$1/\varepsilon_{r31}$	$1/\varepsilon_{r30}$	$1/\varepsilon_{r42}$	$1/\varepsilon_{r41}$	$1/\varepsilon_{r40}$
Simple UEG Theory	0.3	0.22	0.18	0.3	0.22	0.18	0.3	0.22	0.18	0.3	0.22	0.18
Data Fit	0.255	0.193	0.162	0.172	0.117	0.11	0.2	0.097	0.097			
(MeV)	W_{12}	W_{11}	W_{10}	W_{22}	W_{21}	W_{20}	W_{32}	W_{31}	W_{30}	W_{42}	W_{41}	W_{40}
Simple UEG Theory	0.5	0.51	0.51	938.3	950.5	950.5	1740	1763	1763	4242	4297	4297
Data Fit	0.5			938.3	939.6	939.6	1740	1816	1816	4242	4429	4429

Meson Factors:

$$\alpha'_{mi2} = W_{sni2} / W_{i2}; \quad \alpha'_{mi2} = 0.0945 (Data\ Fit); \quad \alpha'_{mi2} = 0.192 (UEG\ Theory)$$

$$\alpha_{mi2} = W_{sni2} / (W_{i2} / 2); \quad \alpha_{mi2} = 0.189 (Data\ Fit); \quad \alpha_{mi2} = 0.384 (UEG\ Theory)$$

$$\alpha'_{mi1} = W_{sni1} / W_{i1}; \quad \alpha'_{mi1} = 0.1345 (Data\ Fit); \quad \alpha'_{mi1} = 0.226 (UEG\ Theory)$$

$$\alpha_{mi1} = W_{sni1} / (W_{i1} / 2); \quad \alpha_{mi1} = 0.269 (Data\ Fit); \quad \alpha_{mi1} = 0.452 (UEG\ Theory)$$

Notes:

- Data-fit and UEG theoretical values for the meson factor for any general energy W, or its equivalent mass m, is provided separately in a graphical plot (see Fig.7).

- Energy W, or its equivalent mass m, of a particular level and shell listed above is twice the associated UEG static (without spin) energy/mass. The listed energy/mass is the total energy/mass of the particular level and shell if there is a spinning charge layer at the particular shell and level.