A Generalized Unified Electro-Gravity Theory for the Proton, and Related Composite Particles

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Outline of Presentation

- The basic Unified Electro-Gravity (UEG) theory for a ``static'' electron, without spin (Ref: APS April 2020 meeting)
- A generalized UEG theory for other simple or composite particles
  - UEG model of the proton: proton's effective radius and g-factor
  - UEG model of composite particles, with additional charge layers surrounding a proton : neutron, pion and muon
- Conclusion

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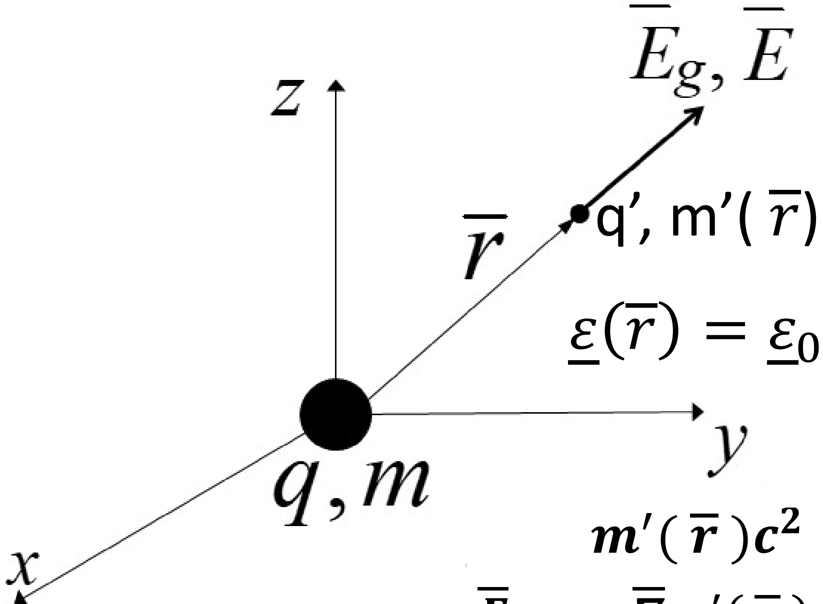
Basic UEG Model of Electro-Gravitational $\overline{E}_g$ and Electric $\overline{E}$ Fields of an Elementary Particle with Charge q and Mass m



Alternate Energy Densities:
W_τ and $W'_\tau = W_\tau + \overline{\nabla}\cdot(\zeta\hat{r}W_\tau)$

$W'_\tau \gg W_\tau\,,\ W'_\tau \approx \overline{\nabla}\cdot(\zeta\hat{r}W_\tau)$

$$\underline{\varepsilon}(\overline{r}) = \underline{\varepsilon}_0\underline{\varepsilon}_r(\overline{r}) = 1/\varepsilon(\overline{r})$$

$\gamma = UEG\ Constant$

$$m'(\overline{r})c^2 = m'_0\underline{\varepsilon}_r(\overline{r})c^2$$

$$\overline{F}_g = -\overline{\nabla}m'(\overline{r})c^2 = -c^2m'_0\overline{\nabla}\underline{\varepsilon}_r(\overline{r})$$

$$\overline{E}_g = \frac{\overline{F}_g}{m'_0} = -c^2\overline{\nabla}\underline{\varepsilon}_r(\overline{r}),$$

$$\overline{\nabla}\cdot\overline{E}_g = -\frac{4\pi G W'_\tau}{c^2} \approx -\frac{4\pi G}{c^2}\overline{\nabla}\cdot(\zeta W_\tau\,\hat{r})$$

$$\overline{E} = \frac{q}{4\pi r^2}\underline{\varepsilon}(r)\hat{r},$$

$$\overline{E}_g \approx -\frac{4\pi G\zeta}{c^2}W_\tau\hat{r} = -\gamma W_\tau\hat{r}$$

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Basic UEG Solutions for the Inverse-Permittivity Function and Mass of a Static Electron

$$\bar{E}_g = -c^2\bar{\nabla}\varepsilon_r(r) \simeq -\gamma W_\tau \hat{r}, \quad \frac{\partial \varepsilon_r(r)}{\partial r} \simeq \frac{\gamma W_\tau}{c^2} = \frac{\gamma D^2 \varepsilon_r'}{2c^2\varepsilon_0} = \frac{\gamma}{16\pi^2 r^4 \varepsilon_0 c^2}\int_0^q \varepsilon_r(q)\,q\,dq$$

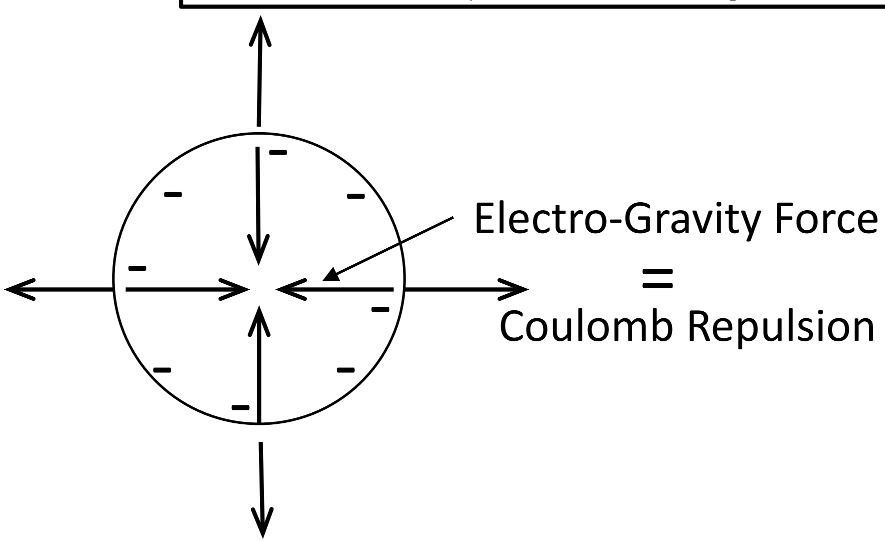
$$\frac{\partial^2 \varepsilon_r(r,q)}{\partial(r^{-3})\,\partial(q^2)} \simeq -\frac{r_\mu^3}{4q^2}\varepsilon_r(r,q), \quad r_\mu^3 = \frac{\gamma q^2}{24\pi^2\varepsilon_0 c^2}, \quad \boxed{r_\mu = 5.14\times10^{-16}\gamma^{1/3}}$$

$$\boxed{\varepsilon_r(r) = 1 - \frac{t^2}{2^2[1!]^2} + \frac{t^4}{2^4[2!]^2} - \frac{t^6}{2^6[3!]^2} + \ldots = J_0(t), \quad t = \left(\frac{r_\mu}{r}\right)^{1.5}}$$

$$\varepsilon_r'(r) = \frac{2}{q^2}\int_0^q \varepsilon_r(r,q)\,q\,dq = 1 - \frac{t^2}{2^2[1!]^2\times 2} + \frac{t^4}{2^4[2!]^2\times 3} - \frac{t^6}{2^6[3!]^2\times 4} + \ldots = \left(\frac{2}{t}\right)J_1(t)$$

$$\boxed{W = m(r)c^2 = \iiint_\tau \frac{q^2\varepsilon_r'}{32\pi^2 r^4\varepsilon_0}\,d\tau = \int_r^\infty \frac{q^2\varepsilon_r'(r)}{8\pi r^2\varepsilon_0}\,dr = m_\mu c^2\sum_{k=0}^{\infty}\frac{(-1)^k t^{(2k+2/3)}}{2^{2k}(k!)^2(k+1)(3k+1)}, \quad m_\mu = \frac{q^2}{8\pi\varepsilon_0 r_\mu c^2}}$$

$$\boxed{m_\mu = 2.49\times10^{-30}\times\gamma^{-1/3}}$$



The new electro-gravitational attraction counters the self-repulsive force of the charge, resulting in a self-consistently stable charge structure.

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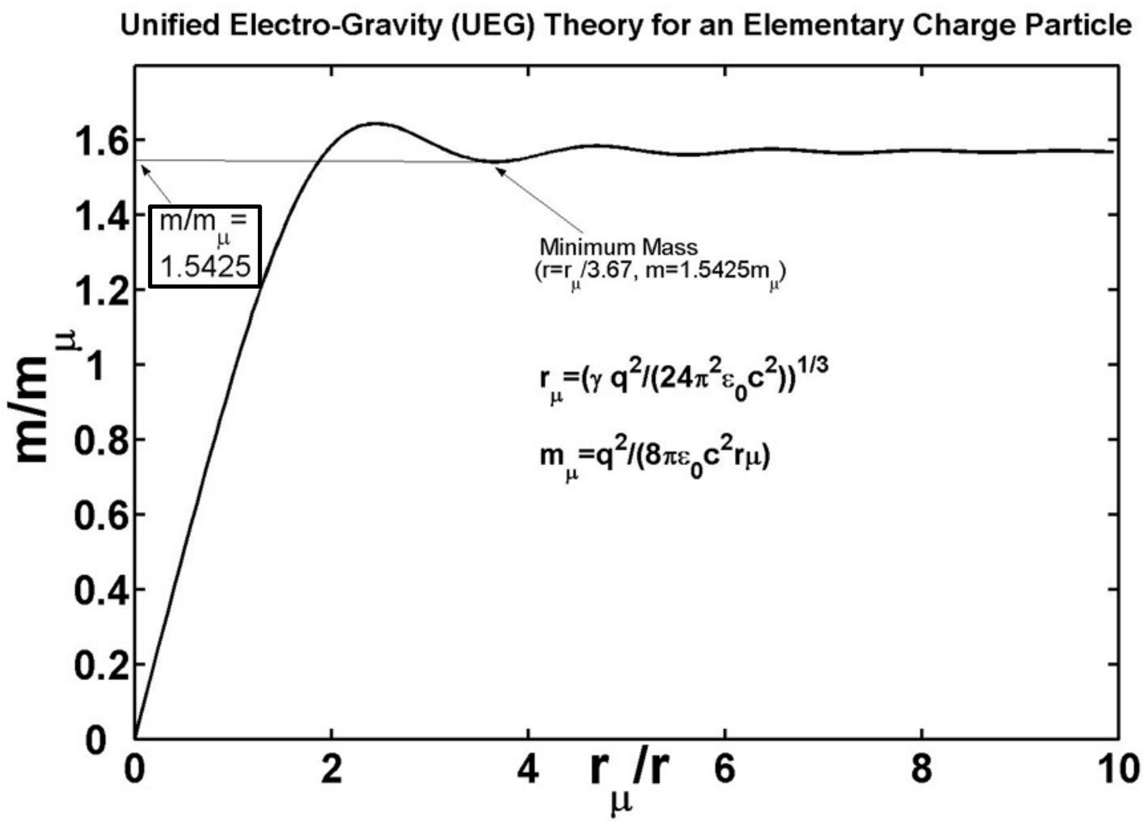
The UEG and Fine-Structure Constants Related by the Normalized Mass Function of an Elementary Charge Particle



$$\left(\frac{m_\mu}{m'_e}\right)^3 = \frac{3q^4}{64\pi c^4 \varepsilon_0^2 \gamma m_e'^3} = \frac{3r_e'^2\pi}{\gamma m'_e},\ m'_e = \frac{q^2}{8\pi\varepsilon_0 c^2 r'_e}$$

$$\boxed{\frac{4\gamma m'_e}{r_e'^2} = 12\pi\left(\frac{m'_e}{m_\mu}\right)^3 = 12\pi\times(1.5425)^3 = 138.360 \simeq \frac{1}{\alpha},\ \alpha = \text{Fine-Structure Constant}}$$

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Dimensionless Relationship Between the UEG Constant, Mass and Classical Radius of an Elementary Charge Particle – Origin of the Fine Structure Constant

$$\frac{m_e'}{m_\mu} = \frac{m_e}{2m_\mu} = 1.5425,\ m_\mu = 2.49\times10^{-30}\times\gamma^{-1/3} = \frac{m_e}{3.085},\ m_e = 9.1\times10^{-31}\,kg$$

$$\gamma^{-1/3} = \frac{m_e}{2.49\times3.085\times10^{-30}} = 0.1185,\ \boxed{\text{UEG Constant } \gamma = 5.997\times10^{2}(m/s^2)/(J/m^3)}$$

$$m_e = \text{electron mass with spin},\ m_e' = \text{"static" electron mass with no spin} = \frac{m_e}{2}$$

$$(\frac{m_\mu}{m_e'})^3 = \frac{3q^4}{64\pi c^4\varepsilon_0^2\gamma m_e'^3} = \frac{3r_e'^2\pi}{\gamma m_e'},\ m_e' = \frac{q^2}{8\pi\varepsilon_0 c^2 r_e'},\ m_e = \frac{q^2}{8\pi\varepsilon_0 c^2 r_e},\ r_e' = 2r_e$$

$$\boxed{\frac{\gamma m_e'}{r_e'^2} = 3\pi(\frac{m_e'}{m_\mu})^3 = 3\pi\times(1.5425)^3 = 34.590 \simeq \frac{1}{4\alpha},\ \frac{\gamma m_e}{r_e^2} = 8\times\frac{\gamma m_e'}{r_e'^2} = 276.720 \simeq \frac{2}{\alpha}}$$

α = Fine-Structure Constant

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Generalization of the UEG Theory to Model Other Charged Particles

- The fixed UEG constant γ is replaced by a general UEG function $\gamma(r)$, dependent on the radial distance (r) or equivalent energy density.
- The general UEG function $\gamma(r)$ maybe discretized into fixed constants γ_i for different ranges of radius or equivalent energy density.
- Extending the dimensionless relationship $\frac{\gamma m_e}{r_e^2} = \frac{2}{\alpha} = \frac{\gamma_i m_i}{r_i^2}$ would result in having stable charged particles of increasing mass m_i (and other close masses m_{ij}) with proportionately smaller classical radius r_i, associated with appropriately smaller UEG constant γ_i

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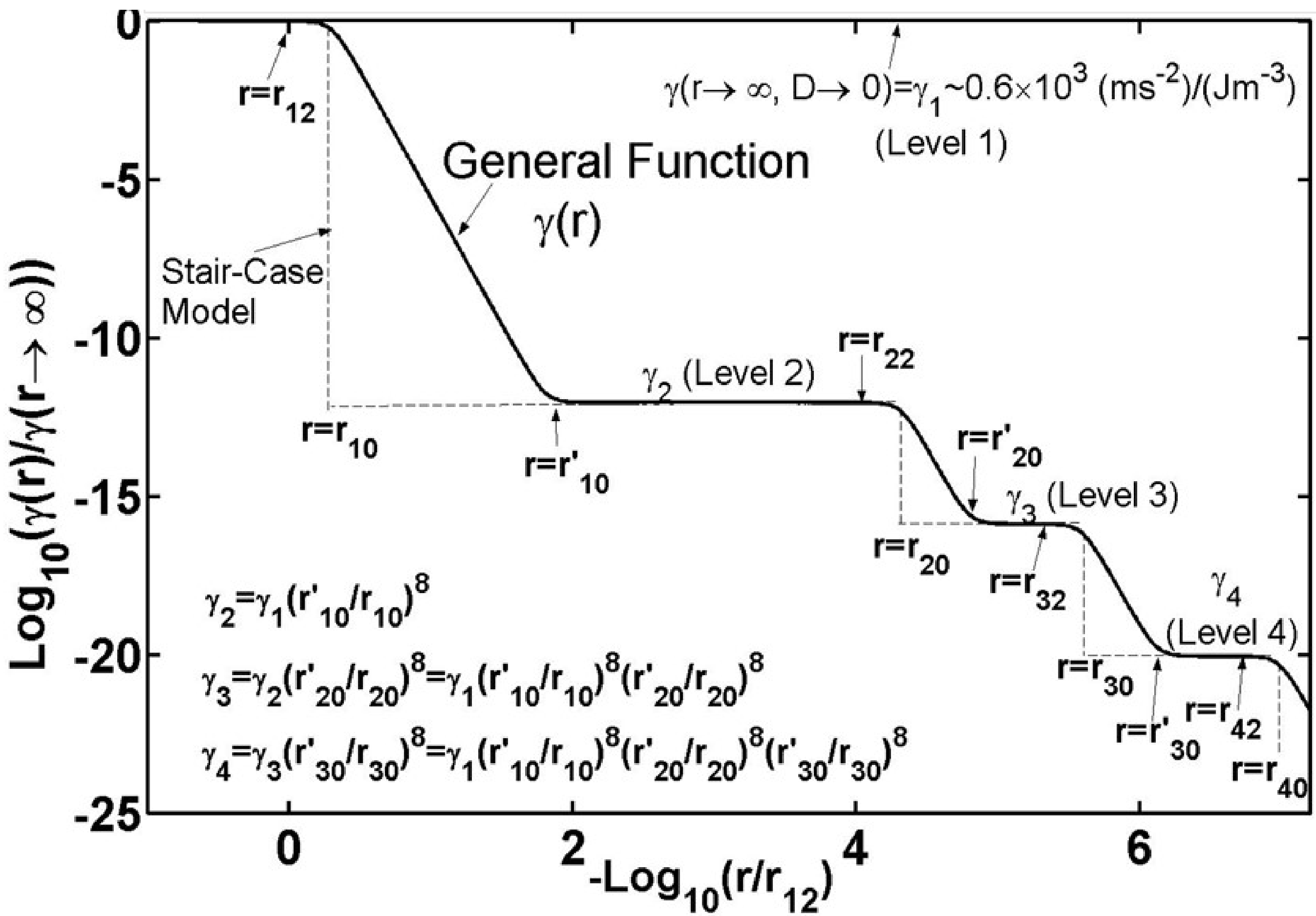
A Generalized UEG Model: A General UEG Parameter $\gamma(r)$, as a Function of Radial Distance (r)



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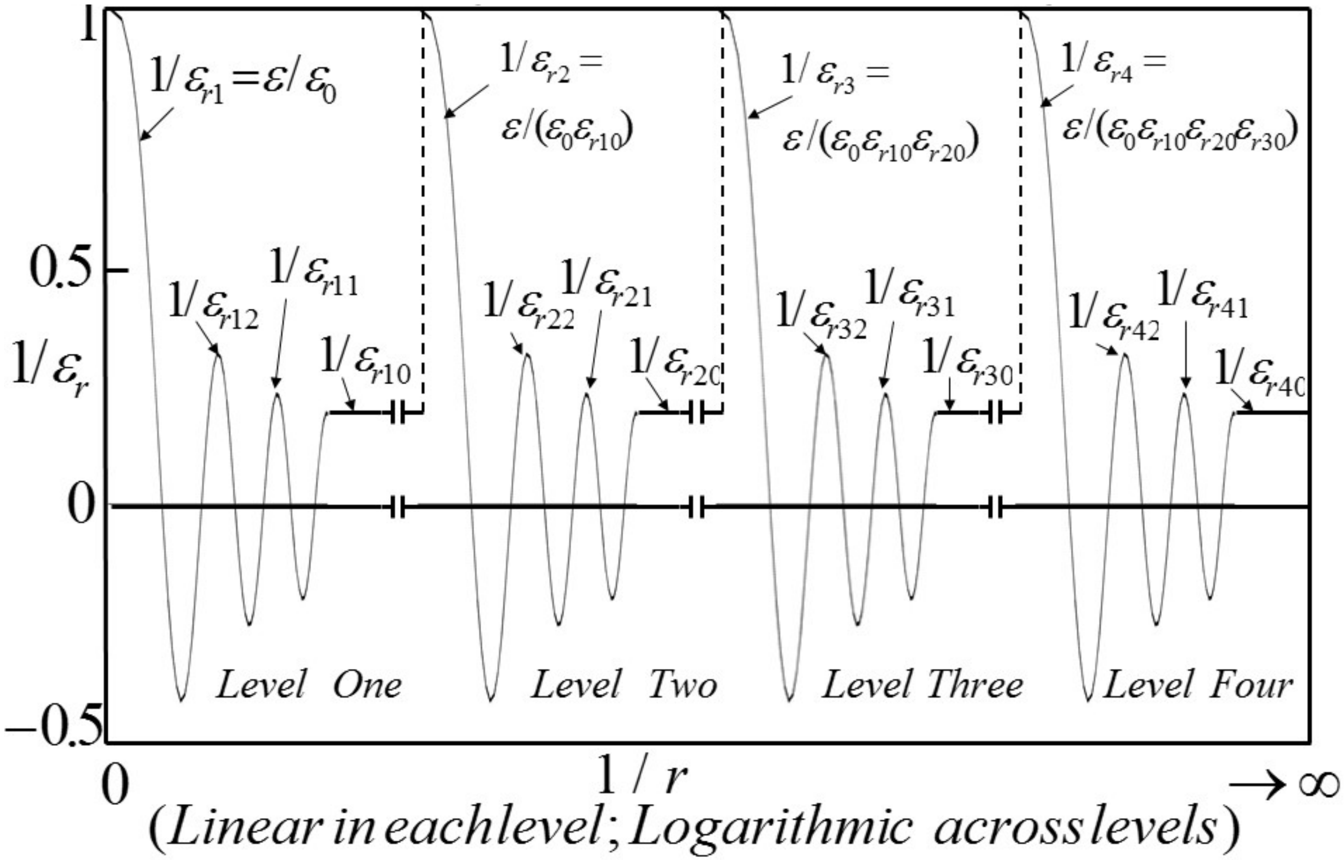
A Generalized UEG Model: A General Inverse Relative Permittivity $1/\varepsilon_r$(r) as a Function of Radial Distance (r)



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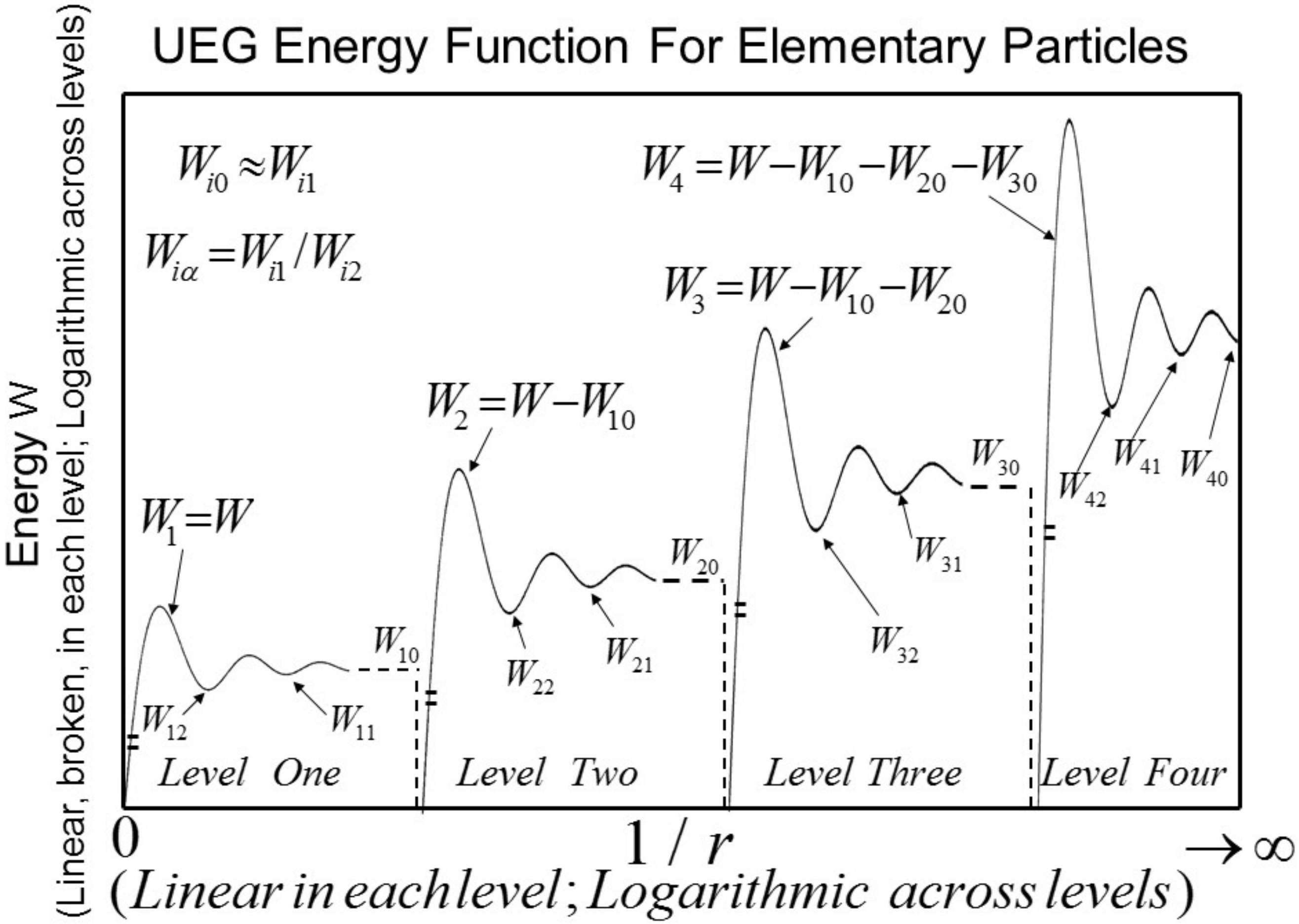
A Generalized UEG Model: A General Energy W(r) or Mass ($m(r)=W(r)/c^2$) Function, for Different Radial Distance (r) or Equivalent Energy Level (i)



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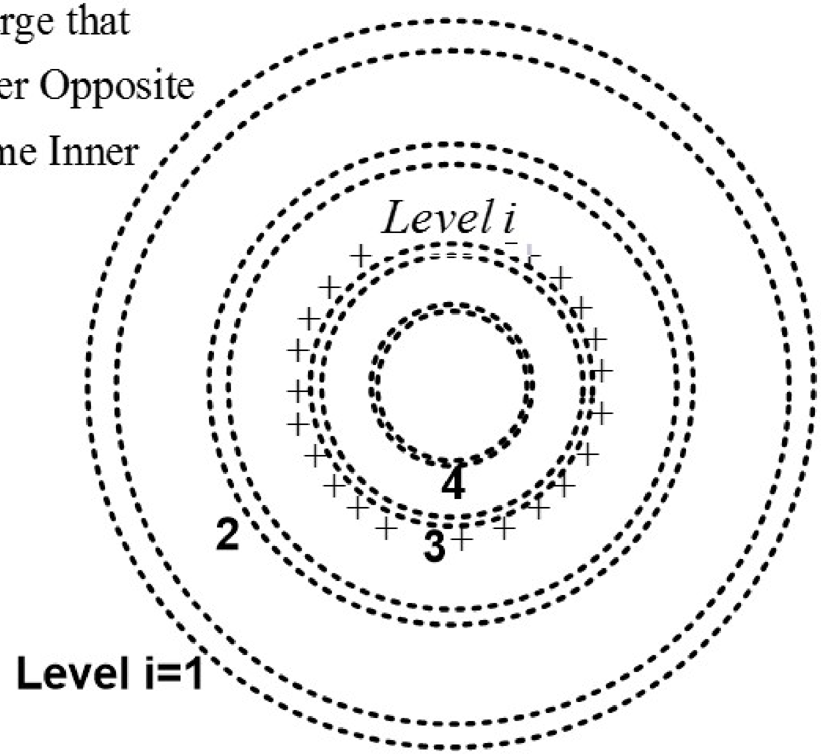
For a Neutral Particle:
$\underline{i}$ is the Outer-Most Level
Having a Charge that
Sheilds another Opposite
Charge at Some Inner
Level $i \geq \underline{i}$

For a Charged Particle (Shown in the Diagram) :
$\underline{i}$ is the Outer - Most Charged Level



Energy Levels of Particles Associated With Distinct Levels of Radial Regions

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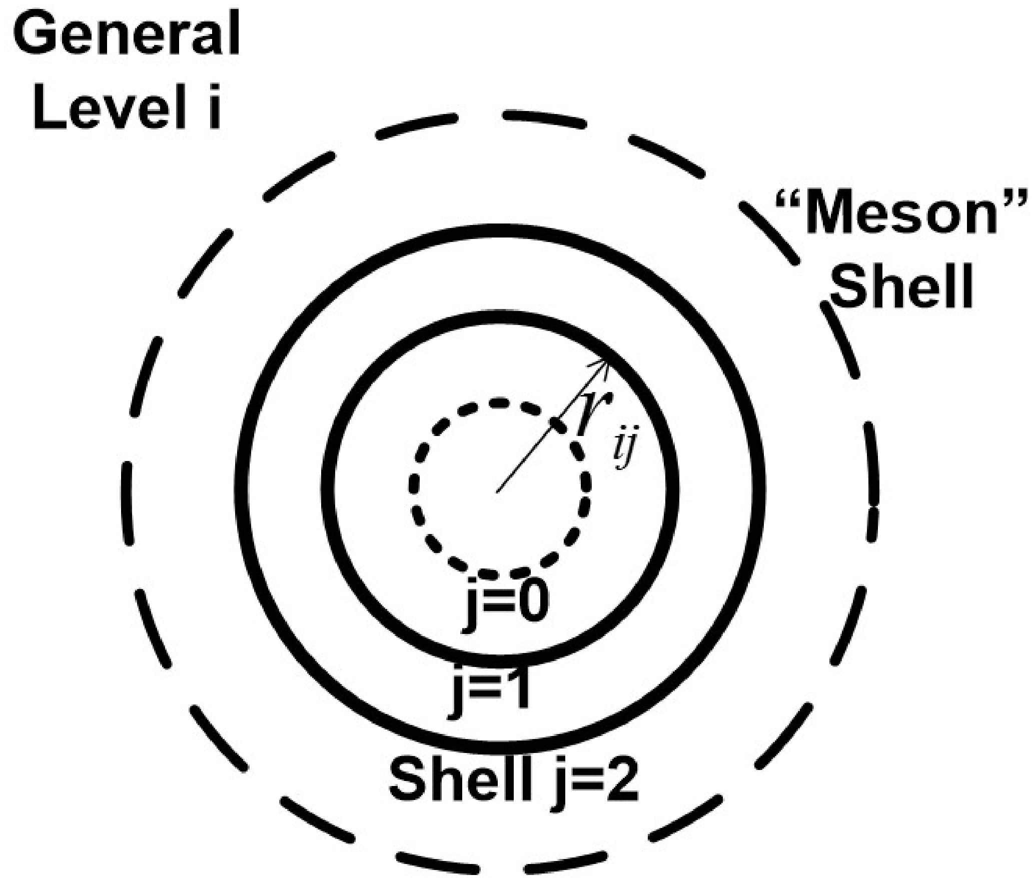

Details of the Radial Region for One Energy Level (i), Having Shells (j) of Finer Structures with Critical Radii r_{ij} and Associated Mass/Energy Sub-Levels m_{ij}

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Generalization of the UEG Theory to Model Other Composite Charged/Neutral Particles

- A neutral particle maybe synthesized by enclosing an elementary charge particle by another charge layer of equal magnitude but opposite sign.
- A stable radius for the enclosing charge exists for each level (i), referred to as the "meson shell'' (in reference to its frequent use for mesons), resulting in a synthesized neutral particle with significantly reduced mass compared to the mass m_i of the original charged particle.
- A new charged particle may be synthesized, by having an original elementary charge particle enclosing a synthesized neutral particle.
- The above mechanisms can then be extended to synthesize other charged/neutral particles with increasing number of charge layers

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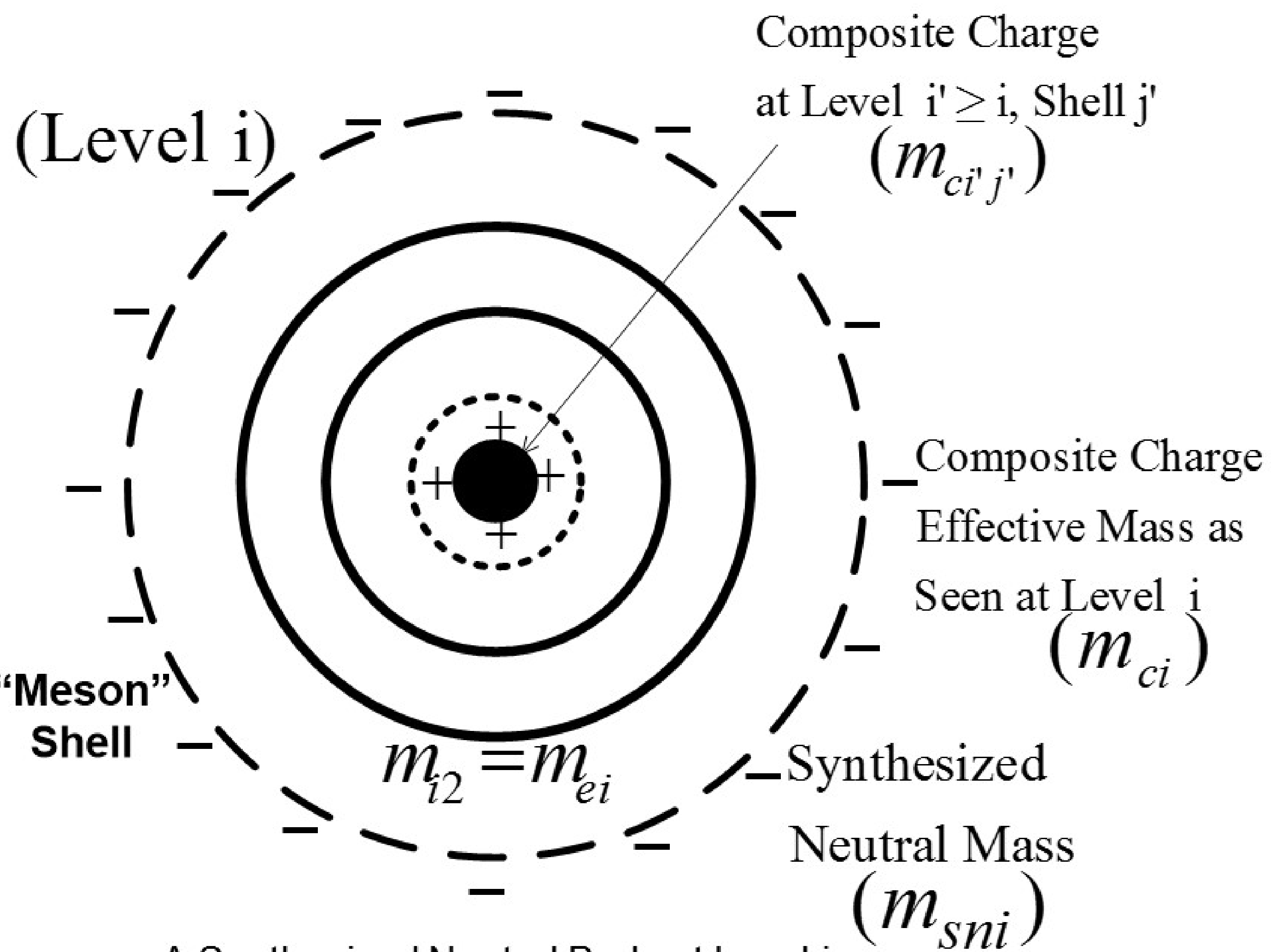
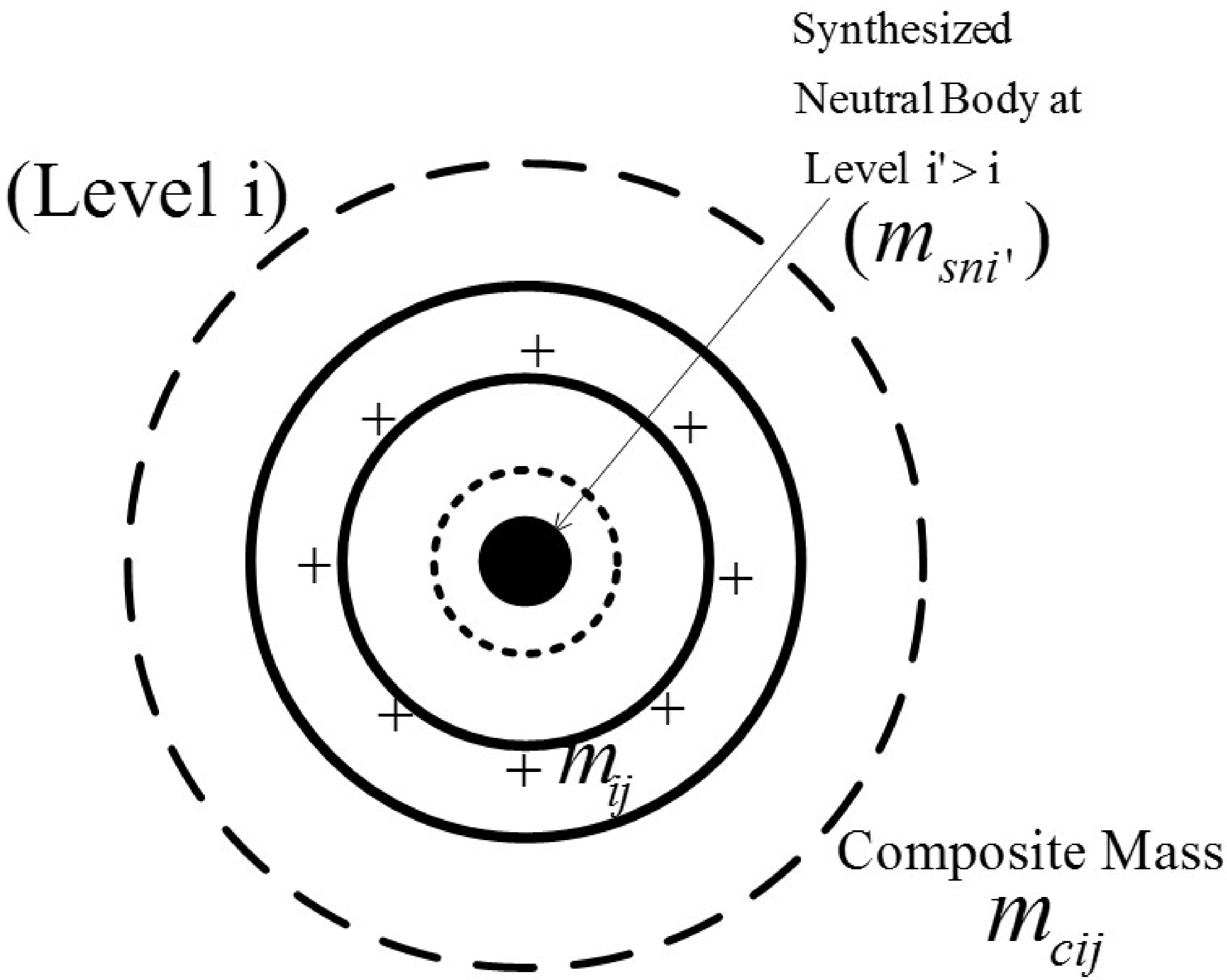


A Synthesized Neutral Body at Level i



A General "Composite" Positive Charged Body Seen at Level i, Shell (j=1,2)

Level-Shell Charge Structure for the UEG Model of an Electron

Level-One			Level-Two			Level-three		
Shells			Shells			Shells		
Meson	Two	One	Meson	Two	One	Meson	Two	One
	−							

Level-Shell Charge Structure for the UEG Model of a Proton

Level-One			Level-Two			Level-three		
Shells			Shells			Shells		
Meson	Two	One	Meson	Two	One	Meson	Two	One
				+				

Level-Shell Charge Structure for the UEG Model of a Neutron

Level-One			Level-Two			Level-three		
Shells			Shells			Shells		
Meson	Two	One	Meson	Two	One	Meson	Two	One
−				+				

Level-Shell Charge Structure for the UEG Model of a Muon

Level-One			Level-Two			Level-three		
Shells			Shells			Shells		
Meson	Two	One	Meson	Two	One	Meson	Two	One
		−	−	+				

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Level-Shell Charge Structure for the UEG Model of a Charged (+/-) Pion

Level-One			Level-Two			Level-three		
Shells			Shells			Shells		
Meson	Two	One	Meson	Two	One	Meson	Two	One
	+/−		−	+				

Level-Shell Charge Structure for the UEG Model of a Neutral Pion

Level-One			Level-Two			Level-three		
Shells			Shells			Shells		
Meson	Two	One	Meson	Two	One	Meson	Two	One
−	+		−	+				

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Generalized UEG Model of a Proton

- Proton is the elementary charge particle, with its charge in the "second level" supported by the general UEG theory.
- Proton's energy level is the immediate next level, as compared to the "first (basic) level" associated with the electron.
- The "structure of the empty space" of an electron is identical to that in the outer part of a proton. Therefore, "proton's effective radius (~0.85 fm)" is comparable to the "electron's effective radius ~ classical radius (~1.4 fm)."
- The surrounding empty space in the immediate vicinity of the proton's charge ("second level medium") is effectively denser, as compared to that of the electron's charge. Therefore, the g(gyromagnetic)-factor for a proton (~5.6) is higher than that for an electron (~2).

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UEG Composite Particles Related to Proton: The Neutron

- Neutron is a composite particle having a negative charge surrounding a proton, placed in the "level-one meson shell" of the proton. This results in the mass/energy of a neutron (939.6 Mev) close to that of a proton (938.3 Mev).
- There maybe two similar neutron structures, one associated with a "heavy proton," and the other with the regular proton. The former, with a higher neutron mass is unstable (a standard, isolated neutron?), whereas the later, with a lower neutron mass, would be stable (neutron inside nucleus?)
- The two alternate neutron models may explain the different natures of an atomic nucleus (stable), and an isolated free neutron (unstable)

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UEG Composite Particles Related to Proton: Pion and Muon

- Pion and Muon are similar composite particles, as per the UEG model, having comparable mass (pion ~140Mev, muon ~106Mev). Charged pions and muons each consists of a proton structure, surrounded by a negative charge in the "level-two meson shell," and then surrounded by a positive or negative charge in the level-one.
- The difference between a pion and a muon is that, the charge in the outer-most level for the pion occupies the shell 2 (outer), whereas that for the muon occupies the shell 1 (inner). This would explain the smaller mass of the muon, compared to the pion, as per the UEG model.
- A neutral pion has an additional charge layer in the "level-one meson shell," of opposite sign compared to the level-one charge, resulting in the zero total charge, and a slightly lower mass compared to the charged pion.
- The g(gyromagnetic)-factor for the muon can be related to the g-factor associated with the outermost charge ("a heavy electron"), that is slightly different from the g-factor of an electron

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Conclusions

- The basic UEG model for the electron can be generalized to self-consistently model similar elementary charged particles (proton), with the charge located at a smaller radius, having increasingly higher levels of energy/mass.
- Other charged or neutral particles can be synthesized as composite structures, with two or more layers of charges. These composite particles are "quasi-stable" structures having different orders of stability.

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Conclusions

- The generalized UEG model, with suitable discrete values of the "UEG constant γ_i" for different energy levels (i), or using a rigorous "continuous UEG function $\gamma(r)$," is shown to self-consistently model a proton, neutron, muon and pion (charged or neutral).
- The generalized UEG model properly predicts (a) the closeness of the effective radii of a proton and an electron, (b) a larger proton g-factor than the electron g-factor, and (c) comparable masses of all pions and a muon.

Conclusions

- The generalized UEG theory can be similarly used to model/predict as well other composite charged neutral particles, for example, a neutrino with a zero (very small) mass but with a non-zero angular momentum ($\hbar/2$).
- Considering the diverse scope and validity of the UEG theory, it may provide a unified paradigm as a potential substitute for the standard model of particle physics?