Elektrogravity Structure of a Particle

Radomir Majkic
E-mail: radomirm@hotmail.com
Dobrinoviceva 11/29, Beograd
Srbija

PART: 1 Particle Evolution

Abstract: Among all unanswered questions in the Physics like quantization of the gravity, fields unification and so on, the question of the particle mass creation and its mass quantization deserve special attention. This paper is about the evolution of the physical particle-supported by the electro and gravity forces. Unexpectedly, electric charge and gravity unify into electro-gravity interaction in the presence of the Planck masses on a very fundamental level, and the electric charge, gravity, and mass are inseparable entities. Moreover, electro-gravity necessarily polarises the Planck masses.

Particle formes from the vacuum.The minimum of the static action creation principle introduces the evolution time derivative, which further defines the particle tangent space and its evolution kinetic energy. The particle self-interaction energy is its electro and gravity interaction energy. All of this is necessary and sufficient to write the first-order, nonlinear particle evolution equations for its electro and gravity interactions and the mass state variables.

The article contributes the particle polarization classification, two-dimensional particle internal geometry and its internal space and time. In addition, it contributes the implicit mass solutions for some particular interaction cases, and describes the character of the particle development in the general case. And finally, the article predicts the universal mass unit $1_{\mathrm{M}_o} = \mathbf{0.565}\left[\mathrm{meVc}^{-2}\right]$, consistent with mass $m_{\nu_e} = 1.17\, meV$, of the lightest, the electron neutrino.

Keywords: Electro-gravity, Planck masses, interaction time derivative, interaction variables, Planck particles.

0.1 Introduction

Sophisticated physical theories are developing to understand and explain many of the secrets of the resourceful nature of the physical particles. Special relativity, the theory of the space and time and the matter motion teaches that there is a particle energy minimum that is the particle rest energy in the set R^+. The experiments show that the particles are distinct objects distinguished by the discrete and fixed spectrum of the rest of the energies, and the set of all particles is countable.

All of this indicates that there is a natural law which systematically builds and distributes particles by their masses. However, the simplest and the most important questions: "What physical law builds and redistributes particles according to masses, and why the particles of the same kind have the same, strictly prescribed masses" are without answer.

In Special Relativity, the theory of the motion of matter in the space and time the particles are already embedded objects of a prescribed rest mass, and the Special relativity cannot tell anything about the particle structure and evolution. General relativity, the theory about the dynamics of the matter-energy and space-time does not tell anything, or we do not know it yet, about the structure

of the particle and their mass build-up.
Electrodynamics and quantum field theories acknowledge the discreet structure of the particles and all their physical attributes in the already existing world, and do not have an inherited ability to say anything about the formation of the particles. All these theories are theories of motion of already existing particles and are not inherently designed to reveal the reality of particles in the realm of the world of the matter rest state.

All this suggests that there is a theory that describes the physical world of the state of the rest and that the world does not need to be at rest the way we expect. Thus, there may be a nontrivial theory of the particle evolution.

This article is a naive attempt to construct such a theory. We are constructing physical particles supported only by the electric and gravity forces in the physical world spanned by the Planck universal constants: $\hbar, \mathrm{C}, \mathrm{G}$), Planck charge, Planck mass and Planck length and time

$$\mathrm{E}_p^2 = \hbar\mathrm{C}, \quad \mathrm{M}_p^2 = \frac{\hbar\mathrm{C}}{\mathrm{G}}, \quad \mathrm{L}_p^2 = \frac{\hbar\mathrm{G}}{\mathrm{C}^3}, \quad \mathrm{T}_p^2 = \frac{\hbar\mathrm{G}}{\mathrm{C}^5}.$$

Observable electric charge $\mathrm{E}^2 = \alpha\hbar\mathrm{C} = \alpha\mathrm{E}_p^2$, where $\alpha = 1/137$ is the constant of the fine structure, its inverse $\overline{\alpha} = 1/\alpha = 137$, is smaller than the Planck charge. Since $\mathrm{E}_p^2 = \mathrm{M}_p^2\mathrm{G}$ it follows that $\mathrm{E}^2 = \alpha\hbar\mathrm{C} = \alpha\mathrm{M}_p^2\mathrm{G} = \mathrm{M}_{\mathrm{M}}^2\mathrm{G}$ and $\mathtt{M}_{\mathrm{M}} = \sqrt{\alpha}\mathrm{M}_p$ the Maxwell mass of the electron. Numerical value of the Planck mass is $\mathtt{M} = 2.18 \cdot 10^{-5}$ gr so that the Maxwell mass of the electron is $\mathtt{M}_{\mathtt{M}} = 1.86 \cdot 10^{-6}$ gr.

The gravity radius of a massive particle m is $\mathrm{R}_g = 2m\mathrm{G}\mathrm{C}^{-2}$, and every particle collapses under its gravity if its mass is squeezed in a sphere of a radius $r < \mathrm{R}_g$. Thus, the condition of the collapse of the particle (m, r) is

$$\frac{\mathrm{R}_g}{r} = \frac{2m\mathrm{G}\mathrm{C}^{-2}}{r} = \frac{2m\mathrm{G}}{\mathrm{C}^2 r} = \frac{\mathrm{G}}{\mathrm{C}^2}\frac{2m}{r} > 1 \quad \Rightarrow \quad \frac{m}{r} > \frac{\mathrm{C}^2}{2\mathrm{G}}.$$

The gravity radius of the light is zero, and the massive bodies have the huge gravity radiuses. Notice that the gravity radius of the Planck mass is double Planck length. There are many particle pairs (m, r), of masses $m < \mathtt{M}$ that satisfy the non-collapse condition $mr^{-1} \leq 2m\mathrm{G}\,\mathrm{C}^{-2}r^{-1}$, and The Planck mass cannot be chosen to be the fundamental mass unit Logical question if there is minimal massive particle (m, r). We will answer this question in the physical world supported by the fundamental Planck constants. An essential question to ask is: "How much of the mass may be stored in a sphere of radius equal to the Planck length?"

Corollary 0.1. *There is no particle of the Planck mass and radius of the Planck length. The largest particle of the radius equal to the Planck length may have at most mass* $\mathtt{M}_{:2} = \mathtt{M}/2$

□ The particle, pair $(\mathtt{M}, r)$ $r = \mathrm{L}_p$ has gravitation radius

$$\mathrm{R}_g = 2\mathrm{M}\mathrm{G}\mathrm{C}^{-2} = 2\mathrm{L}_p > r = \mathrm{L}_p.$$

Thus, the non-collapsing particle of the Planck mass must have a radius greater than the Planck length.

$$\sup_m\{(m, \mathrm{L}_p\} = \mathtt{M}_{:2} = \mathtt{M}/2.$$

Consequently, the only particles of the Planck length radius are of the masses $m \leq \mathtt{M}_{:2}$. ■

Definition 0.2. *The mass* $\mathtt{M}_{:2} = \mathtt{M}/2$ *is the reduced Planck mass. The particle* $\Pi_p \sim (\mathtt{M}_{:2}, \mathrm{E}_p)$, $\mathrm{E}_p = \sqrt{\hbar\mathrm{C}}$ *is the Planck electron and* $\Pi_{\mathtt{M}} \sim (\sqrt{\alpha}\mathtt{M}_{:2}, \mathrm{E}))$, $\mathrm{E} = \sqrt{\alpha\hbar\mathrm{C}}$ *the Maxwell electron.*

The following sets the base of the Physical world based on the Planck constants.

> **A1:** *The smallest natural unit of the length is the Planck length* $L_p = 1.612 \cdot 10^{-33}$ *cm, and the fundamental base of the Physical world is the reduced collection of the Planck constants* $\{L_p, T_p, M_{:2}\}$.

Remark: The change of the particle mass per unit of the electric charge may be estimated on the experimental masses of the particles appearing as the charged and neutral, and N_a is the Avogadro number,

$$\triangle m \approx 7.72 \cdot 10^{-27} \approx \frac{3}{2\alpha} \frac{M_p}{N_a} \text{ gr.}$$

Question: *Which equations describe the particle evolution ?*

We assume that the physical particles form by the extraction from the vacuum. The vacuum is void space equipped with electro and gravity interactions, energy/masses, and other physical properties. Regardless of whether we think the particle forms over the vacuum or in the vacuum, the particle distance from the vacuum is the vector $\vec{r}$ characterized by the size $|\vec{r}| = r$. The level of the particle extraction is measured by the instant statical action $\vec{S} = \int_0^t m\vec{r}\, d\tau$ in the presence of the electro-gravitational interactions $\vec{S} = \int_0^t m\vec{r}\, d\tau$ or the general charge $\mathbf{q} \sim (q, g)$. We remark that the role of gravity in the formulation of the the existing theory of the fields and particles plays a negligible role, and that it may play a significant role in the particle formation and evolution.

0.2 Physical Particle

Physical object characterized by a mass m, electric charge q and a space configuration bounded by a sphere of a radius R in the presence of the electro and gravity interaction (q, g) is the physical particle. The particle is at rest, such is its center of the masses, and its duration is measured by its internal time τ, related to the observable time by a function $\tau = \tau(t)$.

> **A2:** *Electro-gravitational interactions is the entity* (q, g) *defined by the elementary charge* E *and by the Newton gravitational constant* G *by the relations* $\mathrm{q} = \chi \mathrm{E}$ *and* $\mathrm{g} = \gamma^2 \mathrm{G}$. *The functions* γ *and* χ *are intensities of the electro and the gravity interactions. The coefficient* $A_{\chi\gamma} = \chi^2\gamma^{-2}$ *is the relative strength of the electro-gravitational interaction.*
>
> *The Planck mass function* μ_p *is the representative of the equivalence class* $[\mathrm{g}, \mathrm{q}]$ *of the set* $\mathrm{g} \otimes \mathrm{q}$ *such that*
>
> $$d_{\mathrm{g}}\mathrm{q}^2 = \pm\mu_p^2, \quad \forall \mu_p. \tag{A1}$$
>
> *The differential equation (A1) and its solution in the canonical form*
>
> $$\mathrm{q}^2 \mp \mu_p^2 \mathrm{g} = \mathrm{q}_o^2 \in \mathbb{R}, \quad \forall \mu_p \tag{A1*}$$
>
> *are the constitutional equations of the electro-gravity*

Interactions and charges are related. For, $q_g^2 = \mu_p^2 g$, is the gravity in the charge representation so that $\mathbf{q} = (q, q_g) \sim (\mathrm{q}^2, \mu_p^2 g)$ is the general charge in the electric charge representation, and further, we may use either electro-gravitational interaction or general charge. The q_o is the proto charge, and $g_o = \mu_p^{-2}\mathrm{q}_\mathrm{o}^2$ is the proto charge gravitational measure.

While the electro and gravitational interactions have physical dimensions of the electric charge and gravitational constant, the evolution equations have the dimension of the electric charge square. While the electric charge is the source of the electro-interaction, the source of gravity interaction is gravity interaction itself. Otherwise, the gravity electric charge equivalence $\mathrm{q}^2 = \mu_p^2 g$ identifies the gravity interaction by the gravity charge $\mathrm{q}_g^2 = \mu_p^2 g$, and the electro and gravity may be joined to the particle variables. Thus, the particle is $(m, R; q, g)$ at the rest at the coordinate origin. Further on, the electro-gravitational interaction and Planck masses are inseparable, the triplet (q, μ_p, g) is the fundamental entity of the particle interaction. Related to this are the operators $(\hat{q}, \hat{g}, \hat{\mu_p})$ projectors of the interaction to the electro, gravitational, and mass sectors, and

$$\hat{q}^2\hat{g}^{-1} = \hat{\mu_p}^2, \quad \hat{g} = \hat{\mu_p}^2\hat{q}^{-2}, \quad \hat{q}^2 = \hat{\mu_p}^2\hat{g}^{-1}. \tag{A}$$

Remark: *Two signs of the electro-gravity relations refer to the increasing/decreasing charge gravitation gradient we will understand as the electro-gravity polarization of the Planck masses. We assume that $\mathrm{q}_\mathrm{o}^2 \in \mathbb{R}$, and require $\mathrm{q}^2 \geqslant 0$. In the case of the zero proto-electro charge, there are exactly two opposite solutions for the electric charge square. Conditionally, the solution with the negative sign we will call the antigravity solution.*

Planck masses are polarized and the gravity and antigravity solutions of the constitutional equation are just contributions of the polarization of the Planck mass square μ_p^2 or the rest energy square $\mu_p^2\mathrm{c}^4$ by the electro-gravity. We introduce the gravity polarization $\sigma_g = (1, -1)$, the negative sign is for the antigravity, and write the final constitution equation

$$\mathrm{q}^2 - \sigma_g\mu_p^2\mathrm{g} = \mathrm{q}_\mathrm{o}^2 \in \mathbb{R}. \tag{A0*}$$

The introduction and construction of the polarized masses is given by the the following corollary.

Corollary 0.3. *The gravity m_σ, proto $m_{\sigma p}$, and totally polarized masses $\overline{\mathsf{m}}_\sigma$ are*

$$\mathsf{m}_\sigma \ : \ \mathsf{m}_\sigma^2 = \sigma_g\mu_p^2, \tag{A1*}$$
$$m_{\sigma p} : \ m_{\sigma p}^2 = \sigma_g\beta - 2\mu_p^2, \tag{A2*}$$
$$\overline{\mathsf{m}}_\sigma \ : \ \overline{\mathsf{m}}_\sigma^2 = \sigma_g\Phi\mu_p^2, \tag{A3*}$$
$$\Phi \ = (1-\beta^2)^{-1}, \tag{A4*}$$

where $\beta^2 = \mathrm{q}_\mathrm{o}^2\mathrm{q}^{-2} \in \mathbb{R}$ is the coefficient of the proto charge, and the function Φ the polarization function. The polarizations add by the polarization mass reciprocal rule

$$\frac{1}{\mathsf{m}_\sigma^2} - \frac{1}{m_{\sigma p}^2} = \frac{1}{\overline{\mathsf{m}}_\sigma^2} \quad \Leftrightarrow \quad \overline{\mathsf{m}}_\sigma^2 = \frac{\mathsf{m}_\sigma^2 m_{\sigma p}^2}{m_{\sigma p}^2 - \mathsf{m}_\sigma^2}.$$

A mass is principally polarized if it is in the positive $\sigma_g = +1$ sector. The same mass is fundamental if its polarization is reduced to the gravity polarization only.

□ We introduce the polarized mass by the projector $\hat{g}$ of the equation (A0*) into the mass sector. Thus

$$\begin{aligned}
& \mathrm{q}^2 g^{-1} = \sigma_g\mu_p^2 + \hat{g}^{-1}\mathrm{q}_\mathrm{o}^2 = \ \sigma_g\mu_p^2 + \mathrm{q}_\mathrm{o}^2\mathrm{q}^{-2}\cdot\mathrm{q}^2\hat{g}^{-1} \\
\Rightarrow \quad & \overline{\mathsf{m}}_\sigma^2 = \mathsf{m}_\sigma^2 + \beta^2\overline{\mathsf{m}}_\sigma^2 \ \Rightarrow \ \overline{\mathsf{m}}_\sigma^2(1-\beta^2) = \mathsf{m}_\sigma^2 \\
\Leftrightarrow \quad & \frac{1}{\mathsf{m}_\sigma^2} - \frac{\beta^2}{\mathsf{m}_\sigma^2} = \frac{1}{\overline{\mathsf{m}}_\sigma^2} \quad \Leftrightarrow \quad \frac{1}{\mathsf{m}_\sigma^2} - \frac{1}{m_{\sigma p}^2} = \frac{1}{\overline{\mathsf{m}}_\sigma^2} \\
\Rightarrow \quad & \overline{\mathsf{m}}_\sigma^2 = \frac{\mathsf{m}_\sigma^2 m_{\sigma p}^2}{m_{\sigma p}^2 - \mathsf{m}_\sigma^2} = \frac{\mathsf{m}_\sigma^2}{1 - \mathsf{m}_\sigma^2 m_{\sigma p}^{-2}} = \frac{\mathsf{m}_\sigma^2}{1-\beta^2} = \mathsf{m}_\sigma^2\Phi = \ \sigma_g\Phi\mu_p^2.
\end{aligned}$$

■

Remark: Electro-gravity interaction introduces necessarily polarized masses in the creation of the physical particles, and classifies all particles in the class of the totally polarized particles $\overline{\mathcal{P}} = [\mathbf{m}, \beta, \pm\mathbf{1}]$, the class of only the gravity polarized particles $\mathcal{P} = [\mathbf{m}, \mathbf{0}, \pm\mathbf{1}]$. The particles polarized in the positive gravity sector make the principal class $\overline{\mathcal{P}}_{+1} = [\mathbf{m}, \beta, +\mathbf{1}]$ class, and those there in only the gravity polarized make the fundamental particle class $\mathcal{P}_{+1}[\mathbf{m}, \mathbf{0}, +\mathbf{1}]$.

Remark: The electro-gravity constitutional equations in the polarized masses representation are

$$\mathrm{q}^2 = \overline{\mathsf{m}}_\sigma^2 g = \sigma_g (1-\beta^2)^{-1} \mu_p^2\, g = \mu_p^2 g \Phi. \tag{A5*}$$

We notice also that the prime charge operator $\hat{\beta}$ transforms the gravity-polarized mass into total polarized mass and

$$\hat{\beta}:\ \mathsf{m}_\sigma^2 \to \mathsf{m}_\sigma^2\,(1-\beta^2)^{-1} = \overline{\mathsf{m}}_\sigma^2.$$

Parametrization of the Constitutional Equations

Further, we use elementary charge E, gravity constant G and dimensionless interaction entities χ and γ and introduce gravitational charge $\mathrm{q_g}$ to unify into electro-gravity interaction in the representation of the electric charge.

Definition 0.4. *Gravitational charge is the electric charge equivalent of the gravity interaction, and*

$$\mathrm{q_g}:\quad \mathrm{q_g^2} = \mathrm{G}\mu_p^2 \gamma^2.$$

Further on, the general or the electro-gravity charge is the pair $\tilde{q} = (\mathrm{q}, q_{\mathrm{g}})$. After this the canonical interaction equations in the electro-charge representation is

$$\mathrm{q}^2 \mp \mathrm{q_g^2} = \mathrm{q_o^2} \in \mathbb{R}.$$

We are showing that the electro-gravity equation has only three acceptable realizations. Depending on the sign of the $\mathrm{q_o^2}$ there are following four cases:

$$\begin{aligned} & \mathrm{q}^2 \mp \mathrm{q_g^2} = \mathrm{q_o^2} \in \mathbb{R} \\ \Leftrightarrow \qquad & \mathrm{q}^2 \mp \mathrm{q_g^2} = +\mathrm{q_o^2} \geq 0 \quad \Rightarrow \quad \mathrm{q}^2 - \mathrm{q_g^2} = +\mathrm{q_o^2} \ \cdots (\mathbf{a}); \quad \mathrm{q}^2 + \mathrm{q_g^2} = +\mathrm{q_o^2} \ \cdots (\mathbf{b}) \\ & \mathrm{q}^2 \mp \mathrm{q_g^2} = -\mathrm{q_o^2} \leq 0 \quad \Rightarrow \quad \mathrm{q}^2 - \mathrm{q_g^2} = -\mathrm{q_o^2} \ \cdots (\mathbf{c}); \quad \mathrm{q}^2 + \mathrm{q_g^2} = -\mathrm{q_o^2} \ \cdots (d) \end{aligned}$$

All cases except (d) are real. Further, the cases (a) and (c) are hyperbolic with interchanged roles of the electro and gravity interactions, and only the case (b) is elliptic. Thus, all solutions are

$$\begin{aligned} & \mathrm{q} \vee \mathrm{q_g} = \mathrm{q_o} \cosh\theta, \quad \mathrm{q_g} \vee \mathrm{q} = \mathrm{q_o} \sinh\theta, \qquad -\infty < \theta < \infty, \\ & \mathrm{q} = \mathrm{q_o}\cos\theta, \quad \mathrm{q_g} = \mathrm{q_o}\sin\theta, \qquad 0 \leqslant \theta < 2\pi. \end{aligned}$$

Further $\alpha_p = \mathtt{M}^{-2}\mu_p^2$, $\chi_o^2 = \mathrm{q_o^2}\mathrm{E}^{-2}$, and we present step by step transformation of the canonical electro-gravity constitution equation to the representation of the interaction intensities

$$\begin{aligned} \mathrm{q}^2 \mp \mathrm{q_g^2} = \mathrm{q_o^2} \quad & \xrightarrow{\times \mathrm{E}^{-2}} \quad \chi^2 \mp \mathrm{G}\mathrm{E}^{-2}\gamma^2 = \mathrm{E}^{-2}\mathrm{q_o^2} \quad \cdots \\ \cdots \quad & \xrightarrow{\mathrm{E}^{-2} = (\alpha\hbar\mathrm{C})^{-1}} \quad \chi^2 \mp \mathrm{G}(\alpha\hbar\mathrm{C})^{-1}\mu_p^2\,\gamma^2 = \mathrm{E}^{-2}\mathrm{q_o^2} \quad \cdots \\ \cdots \quad & \xrightarrow{\mathrm{G}(\alpha\hbar\mathrm{C})^{-1} = \mathtt{M}^{-2}} \quad \chi^2 \mp \bar{\alpha}\alpha_p\,\gamma^2 = \chi_o^2. \end{aligned}$$

Particle Interaction Energy

The particle interaction energy is the sum of the electro and gravity energies. Exactly, for each $a \in \{\mathrm{q}, g\}$ the self-interaction energy is the sum of the potential energies between all of its parts a' and a'' separated for an r, self-interaction energy. We use the theorem of the summation average and

$$E_a = \sum_{a',a''}^{a,a} \frac{a'a''}{r} = a \cdot \sum_{a'}^{a} \frac{a'}{\mathrm{R}} = \frac{a^2}{R}. \tag{1}$$

> **A3:** *Physical particle at each moment is an object of the high symmetry geometry on the $\mathbb{R}^4_{1,}$ space characterized by its mass m, , or the rest energy $m\mathrm{c}^2$, gravity g and electro q interactions and single space size variable R. The self-interaction energies of the particle are its electro and gravity potential energies*
>
> $$E_{\mathrm{q}} = \frac{q^2}{R}, \quad E_{\mathrm{g}} = -\frac{m^2 g}{R}. \tag{B1}$$

The particle definition is global in the sense that all fine details of the natural laws reduce to an object mass m and call it the particle radius R.

The particle mass, rest energy, radius electro, and gravitational energies are the particle's internal properties, and the electro-gravitational energy of the particle is

$$E_{\mathrm{gq}} = E_{\mathrm{g}} + E_{\mathrm{q}} = -\frac{m^2 g}{R} + \frac{q^2}{R}. \tag{B2}$$

Physical particles are all above, and the particle physical variables are the interaction variables (q, g, μ_p) and the particle variable (m, $\mathbf{q}$, R).

0.3 Particle Evolution Equations

Physical particle is the global object of prescribed mass/energy, electric charge, size, etc, placed at a single point in the space-time $\mathbb{R}^3 \times \mathbb{R}^1$. In this part of the article, we will formulate the particle evolution equations. First, we will give an intuitive motivation for the definition of the very essential evolution time derivative, and that should not be understood as its derivation.

We understand that the particle is extracted from the vacuum in or over the vacuum. We assume that ***1.*** *the mass μ_o of the part of the vacuum directly involved in the particle creation is much larger than the particle mass, and* ***2.*** *that its dependence on time is negligible.* Further on, the particle of a mass $m(\tau)$ and a radius R creates in a time interval $[0, t]$. According to our original setting the particle at each moment of its creation is an object of high symmetry, and that the measure of its creation is a function of its mass and radius only.

We are choosing the creation function to be the functional of the particle static formation action

$$\hat{\mathbf{m}}(\text{vacum}) = \quad S(t) \quad = \int_0^t (\mu_o - m) R \, dt.$$

and define the particle evolution trajectory by the following variational principle.

A4: *Evolution trajectories of the physical particle are the extremals of static action functional $S(t)$ with the fixed boundaries, zero variable variations at the boundaries, and the vacuum-imposed conditions.*

Under all enumerated conditions the extremals must satisfy the following variational equation with the $\delta\tau = 0$ at the integral boundaries:

$$\delta S(t) = \int_0^t \{(\dot{\mu}_o - \dot{m})R + (\mu_o - m)\dot{R}]\delta\tau \, dt = 0$$

With the vacuum imposed conditions $\dot{\mu}_o \approx 0, \;\; \mu_o \gg m$ the under-integral function must be zero, and

$$\therefore \quad (\dot{\mu}_o - \dot{m})R + (\mu_o - m)\dot{R} = 0 \;\; \approx \;\; \dot{m}R - \mu_o\dot{R} = 0 \quad \Rightarrow \quad d_\tau R = \mu_o^{-1} d_\tau m \, R = \;\; \dot{m}\mu_o^{-1}\, R.$$

Definition 0.5. *The evolution time derivative is the multiplication operator $\hat{\text{D}}_\tau = \mu_{\text{BC}}^{-1}\dot{m} \times$ defined on the particle mass and the mass μ_{BC} of its background, with the properties that for all functions A, B and $f(A)$ defined on the particle state:*

$$\begin{aligned}
\hat{\text{D}}_\tau A \quad &\equiv \hat{\text{D}}_\tau(m, A) = \mu_{\text{BC}}^{-1} A \, d_\tau m = \mu_{\text{BC}}^{-1}\dot{m}\, A, \\
\hat{\text{D}}_\tau AB \quad &= \hat{\text{D}}_\tau A\, B + A\, \hat{\text{D}}_\tau B, \\
\hat{\text{D}}_\tau f(A) \; &= \; f'_A \hat{\text{D}}_\tau A, \\
\hat{\text{D}}_\tau^{\,2} A \quad &= \hat{\text{D}}_\tau(\hat{\text{D}}_\tau A).
\end{aligned} \qquad \text{(ED)}$$

The evolution time derivative is sufficient to construct the particle tangent space, its kinetic energy, and finally the particle evolution equations.

Definition 0.6. *The tangent space of the particle is two-dimensional space defined by the particle linear v and angular ω velocities*

$$\begin{aligned}
v &\equiv \hat{\text{D}}_\tau R = \mu_{\text{BC}}^{-1}\dot{m}\, R, \\
\omega &\equiv \hat{\text{D}}_\tau \varphi = \mu_{\text{BC}}^{-1}\dot{m}\, \varphi,
\end{aligned}$$

and the particle kinetic energy is

$$T \;\; \equiv \;\; \frac{k}{2}\, m(\hat{\text{D}}_\tau R)^2 + \frac{k}{2}\, mR^2(\hat{\text{D}}_\tau\varphi)^2 = \quad \frac{k}{2\mu_{\text{BC}}^2}\, \dot{m}^2 m R^2(1+\varphi^2).$$

The particle evolution proceeds in the presence of electro-gravitational force only, and the particle energy is the sum of its kinetic and interaction energy,

$$E \equiv T + E_{\text{gq}} \; = \; \frac{k}{2\mu_{\text{BC}}^2}\, \dot{m}^2 m R^2(1+\varphi^2) + \frac{\text{q}^2 - \text{g}m^2}{R}. \qquad (2)$$

The Newton evolution forces and torques consistent with the particle evolution energy are the generalized forces M, F :

$$\begin{aligned}
\mathsf{M} &\equiv \partial_\varphi T = \frac{k}{\mu_{\text{BC}}^2}\, \dot{m}^2 m R^2 \varphi, \\
\mathsf{F} &\equiv \partial_R T = \frac{k}{\mu_{\text{BC}}^2}\, \dot{m}^2 m R(1+\varphi^2) - \frac{\text{q}^2 - \text{g}m^2}{R^2}.
\end{aligned}$$

Corollary 0.7. *Non-rotating evolving particles achieve the energy minimum and their size and energy there are the following mass functions*

$$R \quad = \frac{3}{2}\,\frac{\text{q}^2 - \text{g}m^2}{E} \qquad (3)$$

$$\mu_B^2 E^3 \quad = \dot{m}^2 m(\text{q}^2 - \text{g}m^2)^2. \qquad (4)$$

$\square$ Conditions for the evolution energy minimum on the evolution space $R \otimes \varphi$ are exactly the equilibrium conditions $M = 0,\ F = 0$. Thus

$$\mathsf{M} \equiv \partial_\varphi T = \frac{k}{\mu_{\mathrm{BC}}^2}\, \dot{m}^2 m R^2 \varphi = 0,$$
$$\mathsf{F} \equiv \partial_R T = \frac{k}{\mu_{\mathrm{BC}}^2}\, \dot{m}^2 m R(1+\varphi^2) - \frac{\mathrm{q}^2 - \mathrm{g}m^2}{R^2} = 0.$$

The only forces involved are the central electro-gravitational forces, there are no either external or internal torques and the equilibrium condition $\varphi = 0 \ \Rightarrow\ \mathsf{M} = 0$ is identically satisfied. The particle creates in non-rotational state. Further we use the equilibrium condition $\mathsf{F} \xrightarrow{\varphi=0} 0$

$$\therefore\quad \frac{k}{\mu_{\mathrm{BC}}^2}\, \dot{m}^2 m R - \frac{\mathrm{q}^2 - \mathrm{g}m^2}{R^2} = 0 \quad\Rightarrow\quad 2T \equiv \frac{k}{\mu_{\mathrm{BC}}^2}\, \dot{m}^2 m R^2 = \frac{\mathrm{q}^2 - \mathrm{g}m^2}{R}. \tag{5}$$

We calculate to confirm that the energy extremum on the particle evolution space is the minimum. Exactly

$$E = \frac{k}{2\mu_{\mathrm{BC}}^2}\, \dot{m}^2 m R^2 + \frac{\mathrm{q}^2 - \mathrm{g}m^2}{R} = 3T, \tag{6}$$
$$\partial_R E = \partial_R 3T = 3 \cdot 2T\, R^{-1} > 0. \tag{7}$$

Thus, the particle evolution energy achieves $E = 3T$ minimum on its evolution space. We use $T = E/3$ in the equation (5) to find that the particle radius, and confirm the equation (4).

$$R = \frac{3}{2}\frac{\mathrm{q}^2 - \mathrm{g}m^2}{E}.$$

Further, we substitute the explicit form of the kinetic energy in the $E = 3T$ for non-revolving particles to find

$$E = 3T = 3 \cdot \frac{k}{2\mu_{\mathrm{BC}}^2}\, \dot{m}^2 m R^2 = \frac{3}{2}\frac{k}{\mu_{\mathrm{BC}}^2}\, \dot{m}^2 m \cdot \left(\frac{3}{2}\frac{\mathrm{q}^2 - \mathrm{g}m^2}{E}\right)^2$$
$$\Rightarrow \qquad E^3 = \frac{9}{8}\frac{k}{\mu_{\mathrm{BC}}^2}\, \dot{m}^2 m \cdot \left(\mathrm{q}^2 - \mathrm{g}m^2\right)^2.$$

We introduce$\mu_B^2 = \frac{3}{2}\frac{k}{\mu_{\mathrm{BC}}^2}$ and the last equation transfers to the equation (4). Undefined factor k is absorbed in the free mass factor μ_B. $\blacksquare$

Remark: *The equations (3) and (4 are the particle size and energy in the function of the mass and not yet its evolution equations. In the next part, we will give the explicit formulation of the evolution equations and finally make their rest energy closure.*

0.4 The Rest Energy Completion

Altogether we have involved six variables, the interaction variables (q, g, μ_p), and the particles internal variable (m, E, R), and we have at our disposal only three independent equations, constitutional equation (A1*) and the particle size and energy equations (3) and (4). The particle description system of the equations is not complete, and at least one new equation without the introduction of the new new variables are necessary. We understand that the particle interaction variables are independent, and all we need to complete the evolving particle equations is

A6: *The evolution of non-revolving physical particle proceeds at its evolution rest state, and all the particle energy at each moment of its evolution is its rest energy* $E = m\mathrm{C}^2$.

The **A6** completes the system of the evolution equations (3) and (4), and energy substitution $E = m\mathrm{C}^2$ reduces the set of all independent variables to the$\{m, R; \mathrm{q}, g\}$, and finally

$$
\begin{aligned}
(3) \implies \quad R &= 3\cdot 2^{-1}\mathrm{C}^{-2}\, m^{-1}(\mathrm{q}^2 - gm^2). && (8)\\
(4) \implies \quad \mu_{B}^2 m^3 \mathrm{C}^6 &= \dot{m}^2 m(\mathrm{q}^2 - \mathrm{g}m^2)^2 \\
\Leftrightarrow \quad & \pm\mu_{B}\mathrm{C}^3 = \dot{m}\, m^{-1}(\mathrm{q}^2 - \mathrm{g}m^2). \\
\Rightarrow \quad & m - \textbf{evolucion particle equations:} \\
m &= 0, && (9)\\
\pm\mu_{B} m^2 \mathrm{C}^3 &= \dot{m}\, m^{-1}(\mathrm{q}^2 - \mathrm{g}m^2) \qquad - \textbf{dual solutions}. && (10)
\end{aligned}
$$

The particle radius is the function of the particle mass, R-evolution equation. The particle mass, m- m-evaluation equations are the first-order differential equations. The particle mass m-evaluation equations are the first-order differential equations. The equation has the massless $m = 0$ and the dual particle mass solutions.

Remark: *While the mass polarization signs are associated with gravity-antigravity, the duality is identified with the particle-anti particle properties of the physical particles.*

It is clear at the first look that the function $X = \mathrm{q}^2 - \mathrm{g}m^2)m^{-1}$ is central to the particle evolution equations and deserves particular attention. Since $X\, dm = \mathrm{q}^2 - \mathrm{g}m^2)m^{-1}dm \sim \dot{m}\, m^{-1}(\mathrm{q}^2 - \mathrm{g}m^2)$ is the X associated differential form the complete system of the particle evolution equations the form of the differentials are the equations

$$0 = m, \tag{E0}$$
$$0 = dm\, X(m, \mathrm{q}, g) \mp \mu_{B}\mathrm{C}^3\, d\tau. \tag{E1}$$
$$R = 3\cdot 2^{-1}\,\mathrm{C}^{-2}\, X(m, \mathrm{q}, g), \tag{E2}$$

completed by the electro=gravity constitutional equations

$$\mathrm{q}^2 - \sigma_g \mu_p^2 \mathrm{g} = \mathrm{q}_{\mathrm{o}}^2, \quad \forall \mu_p, \tag{C1}$$
$$d_g \mathrm{q}^2 = \sigma\mu_p^2. \tag{C2}$$

Now we look at the differential form $X\, dm = \mathrm{q}^2 - \mathrm{g}m^2)m^{-1}dm \sim \dot{m}\, m^{-1}(\mathrm{q}^2 - \mathrm{g}m^2)$.

Corollary 0.8. *The electric charge square differential form $X dm$ is the product of the electro interaction square q^2 and the differential of the dimensionless particle mass function ξ. Exactly*

$$\xi = \ln m^2 - \frac{m^2}{\overline{m}_\sigma^2} = \ln m^2 e^{-m^2 \overline{m}_\sigma^{-2}} \tag{X1}$$
$$2\mathrm{X}\, dm = q^2\, d\xi, . \tag{E2}$$

☐ The physical dimension of the differential form $X dm$ is the dimension of the square of the electric charge interaction function $\overline{\mathcal{Q}}^2$, that will be associated with the particle later. We confirm the Corollary statement by the following calculation

$$
\begin{aligned}
\mathrm{X}\, dm &= \frac{(\mathrm{q}^2 - \mathrm{g}m^2)}{m}\, dm \quad \to \quad \mathrm{q}^2\Big(\frac{1}{m} - m\frac{g}{\mathrm{q}^2}\Big) dm \\
&= \mathrm{q}^2\Big(\frac{1}{m} - \frac{m}{\overline{\mathsf{m}}_\sigma^2}\Big) dm = \frac{\mathrm{q}^2}{2}\, d\Big(\ln m^2 - \frac{m^2}{\overline{\mathsf{m}}_\sigma^2}\Big) = \frac{1}{2}\,\mathrm{q}^2 d\xi
\end{aligned} \tag{X0}
$$

$$
\textbf{def}: \quad \xi = \ln m^2 - \frac{m^2}{\overline{\mathsf{m}}_\sigma^2} = \ln m^2 e^{-m^2 \overline{\mathsf{m}}_\sigma^{-2}} \tag{X1}
$$

$$
\Rightarrow \quad 2\mathrm{X}\, dm = q^2\, d\xi. \tag{X2}
$$

■

In the end, we underline that $\ln m^2 \equiv \ln\left(m^2 1_{\mathrm{M}_o}^{-2}\right)$, 1_{M_o} is the universal mass unit, and that the particle evolution equations are (E0), (E1) and (E2), and finally, all the particle variables and parameters are $\{m, R; q, g; \mu_p; \mu_B, \mathrm{q}_o\}$.

Remark: *Together with the particle creation forms its geometry and the space and time. While the particle is a global object its geometry and the space-time are local objects placed at a particular point of the space-time $\mathbb{R}^3 \times \mathbb{R}^1$. The particle size is the generator of the particle geometry and its space-time, the particle geometry.*

0.5 The Particle Geometry

The particle in the presence of electro-gravity is an object of high symmetry in the physical space and time. The geometry of such an object is its own geometry determined by the content of its mass and electro-gravitational interaction, characterized by a single-length variable radius.

$$
R = \frac{3}{2}\,\frac{\mathrm{q}^2 - \mathrm{g}m^2}{m\mathrm{C}^2} = \frac{3}{2}\,\frac{\mathrm{q}^2}{\mu_p^2 \mathrm{C}^2}\,\frac{\mu_p^2 - m^2}{m} \tag{E2}
$$

The particle radius is zero at the Planck mass $\mu_p^2 = \mathrm{q}^2 g^{-1}$, , changes the sign there, approaches the infinity at the zero particle mass, the photon-like particles, and approaches minus infinity at the infinity particle masses.
However, the negative radius does not have an understandable geometric meaning. Instead, the curvature of the two-dimensional surface acquires both signees, and it is a naturally suited variable to characterize the particle geometry.

We introduce the particle electro $R_{\mathrm{q}} = \mathrm{q}^2(m\mathrm{C}^2)^{-1}$ and gravitational $R_{\mathrm{g}} = \mathrm{g}m(\mathrm{C}^2)^{-1}$ radiuses, identical at the Planck mass. Notice that the gravity radius here is the half of the Schwarzschild gravity radius.

The particle geometry is naturally classified according to the interaction dominance into electro `E` sector when $m < \mu_p$ or $R_{\mathrm{q}} > R_{\mathrm{g}}$ and the gravity sector `G` when $m > \mu_p$, or $R_{\mathrm{g}} > R_{\mathrm{q}}$. The Planck mass is the dividing point.

Further we introduce the electro κ_{q} and the gravity κ_{g} curvatures so that

$$
\begin{aligned}
&\kappa_{\mathrm{q}} \equiv \frac{1}{\mathrm{R}_{\mathrm{q}}} = \frac{m\mathrm{C}^2}{\mathrm{q}^2} \in \mathbb{R}^+, \quad \kappa_{\mathrm{g}} \equiv \frac{1}{\mathrm{R}_{\mathrm{g}}} = -\frac{\mathrm{C}^2}{mg} \in \mathbb{R}^-, \\
\therefore \quad &R = \frac{3}{2}\Big(\frac{1}{\kappa_{\mathrm{q}}} + \frac{1}{\kappa_g}\Big) \quad \Rightarrow \quad \frac{1}{R} = \frac{2}{3}\,\frac{\kappa_g \kappa_{\mathrm{q}}}{\kappa_{\mathrm{q}} + \kappa_g}.
\end{aligned}
$$

Definition 0.9. *The internal geometry of the evolution particle is the geometry of the two-dimensional surface* Σ*. Each particle state corresponds to a point on the surface* Σ *of the local curvature identical to the particle electro-gravity curvature*

$$\kappa = \frac{1}{R} = \frac{2}{3}\,\frac{\kappa_{\mathrm{g}}\kappa_{\mathrm{q}}}{\kappa_{\mathrm{q}} + \kappa_{\mathrm{g}}} \in \mathbb{R}.$$

We recognize that $\mathrm{K} = \kappa_{\mathrm{g}}\kappa_{\mathrm{q}}$ is the local Gauss curvature, and the $\mathrm{H} = \kappa_{\mathrm{q}} + \kappa_{\mathrm{g}}$ the particle local mean curvature. An explicit calculation shows that

$$\begin{aligned} \kappa_{\mathrm{g}}\kappa_{\mathrm{q}} &= -\frac{\mu_p^2 \mathrm{C}^4}{\mathrm{q}^4} = -\mathrm{K}_{gp}^2 < 0, \quad \mathrm{H} = \kappa_q + \kappa_{\mathrm{g}} = \frac{\mathrm{C}^2}{\mathrm{q}^2}\frac{m^2 - \mu_p^2}{m} \\ \Rightarrow \qquad \kappa &= -\frac{2}{3}\frac{\mathrm{K}_{gp}^2}{\mathrm{H}} = -\frac{\mu_p^2 \mathrm{C}^2}{\mathrm{q}^2}\frac{m}{m^2 - \mu_p^2} \in \mathbb{R}. \end{aligned}$$

Remark: **a**) The particle curvature is zero when the particle mass are zero or infinitely large. The particles of zero mass have zero curvature and infinite radius, such are photons. Particles of the small masses, $m < \mu_p$, complete in the electro sector E. sector, for example, photons. The particles of the huge masses $m > \mu_p$ have zero curvature and are completed in the gravity G sector.
b) The particle curvature is singular at the mass identical to the Planck mass and its radius is zero. Electrogravity interacting object of the Planck mass has the singular geometry.

Remark: The sign of the interaction curvature is opposite to the sign of the local mean curvature and the sign of the local mean curvature depends on the sign of the difference between the particle and the Planck masses. The following shows the dependence of the curvature sign on the sign of the mean curvature

$$\begin{aligned} \mathrm{H} > 0 &\Leftrightarrow |\kappa_{\mathrm{g}}| < \kappa_{\mathrm{q}} \Leftrightarrow m > \mu_p &\Rightarrow \kappa < 0 \\ \mathrm{H} = 0 &\Leftrightarrow |\kappa_{\mathrm{g}}| = \kappa_{\mathrm{q}} \Leftrightarrow m = \mu_p &\Rightarrow \kappa = \infty \\ \mathrm{H} < 0 &\Leftrightarrow |\kappa_{\mathrm{g}}| < \kappa_{\mathrm{q}} \Leftrightarrow m < \mu_p &\Rightarrow \kappa > 0. \end{aligned}$$

Remark: **1.** When $|\kappa_{\mathrm{g}}| < \kappa_{\mathrm{q}}$ the particle curvature is negative and the particle is stored in the gravity sector. An example would be the particles inside of the massive bodies.
2. When $|\kappa_{\mathrm{g}}| > \kappa_{\mathrm{q}}$ the particle curvature is positive, and the particle is stored in the electro sector Such particles are electro-dominated. An example would be the particles in our observable world.
3. When $|\kappa_{\mathrm{g}}| = \kappa_{\mathrm{q}}$ the particle curvature is infinite, the particle is stored in the vacuum.

Remark: The particle geometry is the union of the electro and gravity sectors However, our observable world shows that they are rather stored one into another.

Remark: *At this point we could imagine that the particle is a global bounded object of a mass* m *and a radius* R*, bounded in a sphere,* $S^3(R)$*. placed as a local point in the* $\mathbb{R}_1^4$ *space. Thus the particle space is* $\mathbb{R}_1^4 \times S^3(R)$ *The particle has the internal physical geometry described above, and* $S^3(R)$ *has its own internal space-time defined by its physical properties. The particle space-time is the next topic.*

0.6 The Particle Space-Time

The differential form $X\,dm$, equation (E1), relates the particle's internal time to its physical properties. Explicitly

$$\begin{aligned} \dot m\, X = \pm\mu_{B}\mathrm{C}^3 \quad &\Rightarrow \quad \mathrm{X}\,dm = \pm\mu_{B}\mathrm{C}^3\, d\tau \\ \Rightarrow \quad \mathrm{C}\,d\tau = \pm\frac{1}{\mu_{B}\mathrm{C}^2}\, X dm = &\quad \pm\frac{1}{2\mu_{B}\mathrm{C}^2}\,\mathrm{q}^2\, d\xi \qquad \text{(T1)} \\ \Rightarrow \quad \mathrm{C}\,\tau = \pm\frac{1}{2\mu_{B}\mathrm{C}^2}&\int \mathrm{q}^2\, d\xi + const. \qquad \text{(T2)} \end{aligned}$$

Observe that the differential measure $(2\mu_{B}\mathrm{C}^2)^{-1}\,d\xi$, equation (T1), folds the square of the electro-interaction into the distance element over the dimensionless variable ξ. In other words, the $(2\mu_{B}\mathrm{C}^2)^{-1}\mathrm{q}^2$ is the line density over the dimension one dimensionless space. Further, we construct the time-space linear differential form

$$\mathrm{C}d\tau \mp d\mathrm{Z} = d\mathrm{Z}_o + d\tilde{\mathrm{Z}} \Leftrightarrow \mathrm{C}d\tau \mp \frac{\mathrm{q}^2}{2\mu_{B}\mathrm{C}^2}\, d\xi = 0$$

Dimensionless variable $\xi = \xi(m)$ implies $d\xi = \xi'_m\, dm$, so that $(2\mu_{B}\mathrm{C}^2)^{-1}\,d\xi = (2\mu_{B}\mathrm{C}^2)^{-1}\xi'_m\, dm$, and

$$\mathrm{C}d\tau \mp \frac{\mathrm{q}^2}{2\mathrm{C}^2\mu_{B}}\,\xi'_m\, dm = 0, \qquad \text{(G)}$$

is exactly the particle time differential equation in the mass presentation.

In the accord with the relativistic field theory, we understand that each particle is created as the pair $\tilde\Pi = (\Pi, \Pi^*)$ of the particle Π and its antiparticle Π^*. Further on, the negative sign in the equation (G) is for the particle.

Definition 0.10. *The particle internal space-time* $\mathrm{Z}_o \otimes \mathrm{Z}$ *is spanned by the time-space differential elements* $dZ = (d\mathrm{Z}_o,\, d\tilde{\mathrm{Z}})$, $d\,\tilde{\mathrm{Z}} = (d\mathrm{Z}, d\mathrm{Z}^*)$

$$d\mathrm{Z}_o = \mathrm{C}d\tau, \quad d\mathrm{Z} = +\mathrm{q}^2(2\mu_{B}\mathrm{C}^2)^{-1}\xi'_m\, dm, \quad d\mathrm{Z}^* = -\mathrm{q}^2(2\mu_{B}\mathrm{C}^2)^{-1}\xi'_m\, dm.$$

Let $\mathrm{g}_{oo} = c^2\mathrm{q}^2$ and $\mathrm{g}_{mm} = \mathrm{q}^2(2\mathrm{C}^2\mu_{B})^{-1}$ are the metric tensors. Then

$$\begin{aligned} d\mathrm{Z}_o &= \sqrt{\mathrm{g}_{oo}}d\tau & &\Rightarrow & \mathrm{Z}_o &= \sqrt{\mathrm{g}_{oo}}\,\tau \ \ + \mathrm{C}_o, \\ d\mathrm{Z} &= -\sqrt{\mathrm{g}_{mm}}\,dm & &\Rightarrow & \tilde{\mathrm{Z}} &= -\sqrt{\mathrm{g}_{mm}}\,dm + \mathrm{C}. \\ d\mathrm{Z}^* &= +\sqrt{\mathrm{g}_{mm}}\,dm & &\Rightarrow & \tilde{\mathrm{Z}} &= +\sqrt{\mathrm{g}_{mm}}\,dm + \mathrm{C}. \end{aligned}$$

$$\begin{aligned} \therefore \quad dZ: &\qquad \sqrt{\mathrm{g}_{oo}}\,d\tau - \sqrt{\mathrm{g}_{mm}}\,d\,\mathrm{m} = 0, \qquad \text{for } \textbf{particle} \\ d\tilde Z: &\qquad \sqrt{\mathrm{g}_{oo}}\,d\tau + \sqrt{\mathrm{g}_{mm}}\,d\,\mathrm{m} = 0, \qquad \text{for } \textbf{antiparticle}. \end{aligned}$$

Corollary 0.11. *The (particle, antiparticle) pairing introduces the differential metric form* $ds^2 = g_{ij}d\mathrm{z}^i d\mathrm{z}^j$ *consistent with the norm* $|\mathrm{Z}|^2$, *and*

$$|\mathrm{Z}|^2 \ = Z\tilde Z \ = g_{oo}\,\tau^2 \pm g_{mm}\,m^2 = \mathrm{C}\mathrm{C}^*.$$

□ We integrate the dual time equations to find

$$\begin{aligned} Z &= \sqrt{\mathrm{g}_{oo}}\,\tau - \sqrt{\mathrm{g}_{mm}}\,m - \mathrm{C}, \\ \tilde Z &= \sqrt{\mathrm{g}_{oo}}\,\tau + \sqrt{\mathrm{g}_{mm}}\,m - \mathrm{C}^* \\ \Rightarrow \quad Z\cdot\tilde Z &= \mathrm{g}_{oo}\tau^2 \ - \ \mathrm{g}_{mm}\,m^2 = \mathrm{C}\mathrm{C}^*. \end{aligned}$$

The integration constant CC^* may be defined by specialization of the function $\xi = \ln m^2 e^{-m^2/\mu_p^2}$ to the Planck mass at the initial moment $\tau = 0$, so that

$$\mathrm{g}_{oo}\tau^2 \pm \mathrm{g}_{mm}\, m^2 = \text{CC}^* \quad \xrightarrow{\tau=0} \quad \mp \mathrm{q}^{2(}2\mu_{\scriptscriptstyle B}\mathrm{C}^2)^{-1}\xi'_m = \mathrm{cc}^*.$$

■

Remark: *We should recall that together with the creation of the physical particle creates its state $\mathcal{S}$, which is the collection of all physical variables associated with the particle at each level of its development. Such variables are the mass and the charge and gravity interaction functions. The interaction state variables are mutually related by the operations among the projectors $\{\hat{q}, \hat{g}, \hat{\nu}\}$. In the next section, we will construct the particle state or the particle interaction variables.*

0.7 Particle State Variables

Differential element $X\,dm \in \mathbb{R}$ in the equation (E1) is a real function of the dimensionless variable ξ of the dimension of the electric charge square. It is associated with the particle in the evolution and therefore must be the differential element of the particle state variable. The next is the definition of the particle stare variables.

Definition 0.12. *The function*

$$\overline{\mathcal{Q}}^2 \in \mathbb{R} \therefore\ \hat{\mathrm{q}} : \mathcal{S} \rightarrow d\overline{\mathcal{Q}}^2 = 2X\,dm = \mathrm{q}^2 d\xi \tag{E3}$$

$$\xi = \ln m^2 e^{-m^2 \overline{\mathtt{m}}_\sigma^{-2}}, \tag{X1}$$

is the electric charge state variable, further on the electro-state variable), or the interaction charge of the evolving particle.
The interaction mass $\overline{\mathfrak{M}}^2$ and the interaction gravitation $\overline{\mathcal{G}}$ are the state variable projections of the particle state $\mathcal{S}$ into the mass M and the gravity G sectors.

Remark: The particle state is the collection of the properties of the evolving particle. Its projection to the electro-interaction sector $\mathtt{E}$ is exactly the charge interaction function $\overline{\mathcal{Q}}^2$. This defines the particle state $\mathcal{S}$ implicitly as the collection of the evolving particle properties which $\hat{q}$ projection is state variable $\overline{\mathcal{Q}}^2$. Since the operator projectors are mutually related by the equation (A), other state variables are constructed from the state variable $\overline{\mathcal{Q}}$. For:

$$\overline{\mathcal{Q}}^2 \in \mathbb{R} :\ d\overline{\mathcal{Q}}^2 = \mathrm{q}^2 d\xi, \tag{E3}$$

$$\overline{\mathfrak{M}}^2 \in \mathbb{R} :\ d\overline{\mathfrak{M}}^2 = \hat{\mu_p}^2 \mathcal{S} = \hat{g}^{-1}\hat{q}^2\mathcal{S} = \hat{g}^{-1} d\overline{\mathcal{Q}}^2 = \hat{g}^{-1}\mathrm{q}^2 d\xi = \mu_p^2 d\xi, \tag{E4}$$

$$\overline{\mathcal{G}} \in \mathbb{R} :\ d\overline{\mathcal{Q}} = \hat{g}\,\mathcal{S} = \hat{\mu_p}^{-2}\hat{g}^2\mathcal{S} = \hat{\mu_p}^{-2} d\overline{\mathcal{Q}}^2 = \hat{\mu_p}^{-2}\mathrm{q}^2 d\xi = g d\xi. \tag{E5}$$

Dimensionless mass function ξ, induces the structure functions:

$$(\xi, \overline{\mathrm{F}}) :\quad \xi \equiv \overline{\nu} = \ln \overline{\mathrm{F}} \tag{11}$$

$$\overline{\nu} = \ln m^2 - m^2 \overline{\mathtt{m}}_\sigma^{-2} = \ln m^2 - m^2 \mu_p^{-2}\Phi^{-1}, \tag{12}$$

$$\overline{\mathrm{F}} = m^2 e^{-m^2 \overline{\mathtt{m}}_\sigma^{-2}} = m^2 e^{-m^2 \mu_p^{-2}\Phi^{-1}} \tag{13}$$

$$\Phi = \sigma_g (1-\beta)^2)^{-1}. \tag{14}$$

Further on, we are constructing the primitive functions of the particle state variables, and

$$\overline{\mathcal{Q}}^2 = \mathrm{q}^2\overline{\nu} = \mathrm{q}^2 \ln \overline{\mathrm{F}}, \tag{D1*}$$

$$\overline{\mathfrak{M}}^2 = \overline{\mathsf{m}}_\sigma^2 \overline{\nu} = \mu_p^2 \ln \overline{\mathrm{F}}, \tag{D2*}$$

$$\overline{\mathcal{G}} = g\overline{\nu} = g \ln \overline{\mathrm{F}}. \tag{D3*}$$

In addition, the elementary state functions are mutually related in the following way

$$d_m \overline{\mathcal{Q}}^2 = g\, d_m \overline{\mathfrak{M}}^2, \tag{E6}$$

$$d_m \overline{\mathcal{Q}}^2 = \mu_p^2\, d_m \overline{\mathcal{G}}, \tag{E7}$$

$$g\, d_m \overline{\mathfrak{M}}^2 = \mu_p^2\, d_m \overline{\mathcal{G}}, \tag{E8}$$

The state variable $\{\overline{\mathcal{Q}}^2, \overline{\mathfrak{M}}^2, \overline{\mathcal{G}}\}$ are all real functions, the squares in the notation are not the algebraic operations but to signify the variable physical dimension. Notice that all state variables are products of the interaction variables and the dimensionless structure functions.

Corollary 0.13. *The evolutions of the particle state variables are governed by the following differential equations:*

$$\overline{\mathcal{Q}}: \quad d_m \overline{\mathcal{Q}}^2 = q^2\, d\overline{\nu} = q^2 d \ln \overline{F} = \pm 2\mu_{\scriptscriptstyle B} \mathrm{C}^3\, d\tau, \tag{D1}$$

$$\overline{\mathfrak{M}}: \quad d_m \overline{\mathfrak{M}}^2 = \overline{\mathsf{m}}_\sigma^2\, d\overline{\nu} = \overline{\mathsf{m}}_\sigma^2 \ln\, d\overline{F} = \pm 2\mu_{\scriptscriptstyle B}\, g^{-1} \mathrm{C}^3\, d\tau, \tag{D2}$$

$$\overline{\mathcal{G}}: \quad d_m \overline{\mathcal{G}} = g\, d\overline{\nu} = g\, d \ln \overline{F} = \pm 2\mu_{\scriptscriptstyle B} \overline{\mathsf{m}}_\sigma^{-2} \mathrm{C}^3\, d\tau, \tag{D3}$$

$$d_m \overline{\mathcal{Q}}^2 - g\, d_m \overline{\mathfrak{M}}^2 = 0 \tag{D4}$$

□ We use the equations the equations (X1) and (X2) in the m-evolution equation (E1) to produce the equation (D1).

$$\mathrm{X}\, dm - \mu_{\scriptscriptstyle B} \mathrm{C}^3\, d\tau \xrightarrow{\times 2 \text{ and use eqn. } (E2)} q^2\, d\xi \pm 2\mu_{\scriptscriptstyle B} \mathrm{C}^3\, d\tau.$$

The other state variable equations are the projections of the equation (D1). Exactly:

$$\hat{\mu_p}^2 \mathcal{S} \to \quad d\overline{\mathfrak{M}}^2 = \hat{g}^{-1} \overline{\mathcal{Q}}^2 \equiv \pm g^{-1} \cdot 2\mu_{\scriptscriptstyle B} \mathrm{C}^3\, d\tau = \pm 2\mu_{\scriptscriptstyle B}\, g^{-1} \mathrm{C}^3\, d\tau$$

$$\mu_p{}^{-2} \mathcal{S} \to \quad d\overline{\mathcal{G}} = \mu_p{}^{-2} \overline{\mathcal{Q}}^2 \equiv \pm \mu_p{}^{-2} \cdot 2\mu_{\scriptscriptstyle B} \mathrm{C}^3\, d\tau = \pm 2\mu_{\scriptscriptstyle B} \mu_p{}^{-2} \mathrm{C}^3\, d\tau$$

The differential equation (D4) is the representative of the identities (E6),(E7) i (E8). ■

Now, it is straightforward to write the solutions of the particle state variable evolution equations, and

$$\overline{\mathcal{Q}}^2 \equiv \mathrm{q}^2 \overline{\nu} = \pm 2\mu_{\scriptscriptstyle B} \mathrm{C}^3 \tau + C_\pm^q \equiv \mathrm{q}^2 \ln \overline{\mathrm{F}} \in \mathbb{R} \tag{D1.1}$$

$$\overline{\mathfrak{M}}^2 \equiv \overline{\mathsf{m}}_\sigma^2 \overline{\nu} = \pm 2\mu_{\scriptscriptstyle B} \mathrm{C}^3 \tau + C_\pm^m \equiv \overline{\mathsf{m}}_\sigma^2 \ln \overline{\mathrm{F}} \in \mathbb{R} \tag{D2.1}$$

$$\overline{\mathcal{G}} \equiv g\overline{\nu} = \pm 2\mu_{\scriptscriptstyle B} \overline{\mathsf{m}}_\sigma^{-2} \mathrm{C}^3 \tau + C_\pm^{\mathrm{g}} \equiv g \ \ln \overline{\mathrm{F}} \in \mathbb{R} \tag{D3.1}$$

$$\overline{\mathcal{Q}}^2 - g\, \overline{\mathfrak{M}}^2 + const. \tag{D4.1}$$

Remark: We understand that $\pm\, \mu_{\scriptscriptstyle B} \mathrm{C}^3 d\tau = d\mathcal{Q}_{\mathrm{B}}^2 = d(A_b)$ is is the contribution of the particle background to the interaction charge $\overline{\mathcal{Q}}^2$. We should understand that the particle state variables are not the particle contents of charge, mass, and gravity, but the functions of the particle evolution, like the particle energy.

Remark: The elementary relation in the mass state variable identity $d\overline{\mathcal{Q}}^2 = g\, d\overline{\mathfrak{M}}^2$ is not only electric charge state variable interaction mass representation, but the conversation law of the electro-gravity charge in the differential form.

Corollary 0.14. *The electro-gravity charge state variable* $\overline{\mathscr{Q}}^2 \wedge g\overline{\mathfrak{M}}^2$ *is preserved on the particle evolution,* $\mathbf{Q}_\mathrm{o}^2$ *is an initial electro gravity charge state variable, and*

$$\overline{\mathscr{Q}}^2 - g\overline{\mathfrak{M}}^2 = C_\mathrm{o} \in \mathbf{Q}_\mathrm{o}^2. \tag{D4.1'}$$

□ The differential identity (D4.1) implies

$$d_m\overline{\mathscr{Q}}^2 = \mp 2\mu_B \mathrm{c}^3 d\tau = g\, d_m\overline{\mathfrak{M}}^2 \quad\Rightarrow\quad \overline{\mathscr{Q}}^2 - g\overline{\mathfrak{M}}^2 = const.$$

■

Remark: The evolution equations (D1.1, D2.1, D3.1 i D4.1) of the state variables will be completed after the initial conditions are specified to determine the integration constants. We chose that at the moment $\tau = 0$

$$\begin{aligned} \overline{\mathscr{Q}}^2(0) \quad &\equiv \mathrm{q}^2 \ln \overline{\mathrm{F}}(0) = C_\pm^q && \text{(D1.1')}\\ \overline{\mathfrak{M}}^2(0) \quad &\equiv g\overline{\mathsf{m}}_\sigma^2 \ln \overline{\mathrm{F}} = C_\pm^m && \text{(D2.1')}\\ \overline{\mathscr{Q}}^2(0) - g\overline{\mathfrak{M}}^2(0) \quad &\equiv C_\pm^q - C_\pm^m = \ \mathrm{C_o}. && \text{(D4.1'.)} \end{aligned}$$

Extremum of the Mass State Variable

The properties of the particle state variables are prescribed by the properties of the structure functions $\overline{\nu}$ and $\overline{\mathrm{F}}$. We are showing that the mass state variable achieves maximum at the polarized mass square function $\overline{\mathsf{m}}_\sigma^2$, and that

$$\mathfrak{M}_\star^2 = \overline{\mathsf{m}}_\sigma^2 \ln\left(\overline{\mathsf{m}}_\sigma^2 e^{-1}\right) \quad \text{at} \quad m\colon\ m^2 = \overline{\mathsf{m}}_\sigma^2 = \sigma_g \Phi \mu_p^2, \tag{M1}$$

□

$$\begin{aligned} \mathfrak{M}^2 \quad &= \overline{\mathsf{m}}_\sigma^2 \ln \overline{\mathrm{F}} = \overline{\mathsf{m}}_\sigma^2 \ln\, m^2 e^{-m^2\overline{\mathsf{m}}_\sigma^{-2}} = \overline{\mathsf{m}}_\sigma^2(\ln\, m^2 - m^2\overline{\mathsf{m}}_\sigma^{-2})\\ \partial_{m^2}: \quad &\mathfrak{M}^2 \to\ \mathrm{m}_\sigma^2(m^{-2} - \overline{\mathsf{m}}_\sigma^{-2}).\ \ \partial_{m^2}\mathfrak{M}^2 = 0 \Rightarrow m^2 = \overline{\mathsf{m}}_\sigma^2 \ \Rightarrow\ \mathfrak{M}^2(\overline{\mathsf{m}}_\sigma^2) = \overline{\mathsf{m}}_\sigma^2 \ln\left(\overline{\mathsf{m}}_\sigma^2 e^{-1}\right)\\ \partial_{m^2}^2: \quad &\mathfrak{M}^2 = -\overline{\mathsf{m}}_\sigma^{-4} < 0 \ \Rightarrow\ \text{maksimum}. \end{aligned}$$

At the end the function $\mathfrak{M}_\star^2$, call it the extremal mass state variable is

$$\mathfrak{M}_\star^2 \quad = \mu_p^2 \Phi \ln\left(\mu_p^2 \Phi e^{-1}\right), \quad \Phi = \sigma_g(1-\beta^2))^{-1}$$

The extremal mass state is the function of the Planck mass and must be the mass state variable $\mathfrak{M}_\star^2(\mu_p)$ by itself as the evaluation of the state variable.

Remark: The extremal mass states variable is associated with the class of the Planck particles.The function $\mathfrak{M}_\star^2(\mu_p)$ achieves minimum $\mathfrak{M}_\star^2 = 0$ at the Planck mass $\mu_p^2 = \Phi^{-1} = \sigma_g(1-\beta^2)$.

□

$$\begin{aligned} \mathfrak{M}_\star^2 \quad &= \mu_p^2 \Phi \ln\left(\mu_p^2 \Phi e^{-1}\right) = \mu_p^2\Phi(\mu_p^2\Phi + *)\\ \partial_{\mu_p^2}: \quad &\mathfrak{M}_\star^2 \to \Phi \ln \mu_p^2 \Phi.\ \ \partial_{\mu_p^2}\mathfrak{M}_\star^2 = 0 \ \Rightarrow\ \mu_p^2\Phi = 0 \Leftrightarrow \mu_p^2 = \Phi^{-1} \ \Rightarrow\ \mathfrak{M}_\star^2 = 0\\ \partial_{Mp^2}^2: \quad &\mathfrak{M}_\star^2 = 1 > 0 \ \Rightarrow\ \text{minimum}. \end{aligned}$$

□

0.8 Planck Particles

Starting from the Planck mass constant, over the electro-gravity constitutional equations the Planck mass has been silently present in our consideration. It enters the particle evolution equations through the polarization mass $\overline{\mathsf{m}}_\sigma^2 = \sigma_g \mu_p^2 \Phi$, $\Phi = (1-\beta^2)^{-1}$ in the structure functions. However, the informal concept of the Planck particle appears in the evaluation of the extremum of the mass state variable. However, the universality of the state variables implies that the particle mass state variable $\overline{\mathfrak{M}}^2 = \overline{\mathsf{m}}_\sigma^2 \ln \overline{\mathrm{F}}$, $\overline{\mathrm{F}} = m^2\, e^{-m^2 m_\sigma^{-2}}$ prescribes to any particle, and hence, to the particle of the mass equal to the Planck mass. Thus

$$m^2 \overline{\mathsf{m}}_\sigma^{-2} \xrightarrow{m\to\mu_p} \mu_p^2\, \sigma_g \mu_p^{-2} \Phi^{-1} = \sigma_g \Phi^{-1}$$

$$\mathfrak{M}^2 = \overline{\mathsf{m}}_\sigma^2 \ln \left(m^2 e^{-m^2 \overline{\mathsf{m}}_\sigma^{-2}} \right) \xrightarrow{m\to\mu_p} \mathfrak{M}_{\mu_p}^2 \tag{P1}$$

$$\mathfrak{M}_{\mu_p}^2 = \mu_p^2\, \Phi \ln \mu_p^2 1_{\mathrm{M}_o}^{-2} e^{-\sigma_g \Phi^{-1}}. \tag{P2}$$

Definition 0.15. *An abstract object of the mass identical to the Planck mass, realized in any polarization in the equation (P2) is the total polarized Planck particle. Planck particles polarized in the positive gravity sector is the Principal Planck particle, and the Principal Planck particle polarized only in the gravity sector is the Fundamental Planck particle.*

Remark: At this point, we can make the classification of the particles by the polarization.

$$\begin{array}{ccc}
(\overline{\mathcal{P}} : m, \mu, \sigma_g, \overline{\mathrm{F}}) & \xrightarrow{\beta\to\ 0} & (\mathcal{P} : m, \mu, \sigma_g, \mathsf{F}) \\
\hat{\mu}\big\downarrow & & \big\downarrow\hat{\mu} \\
(\overline{\mathcal{P}} : \mu, \mu, \sigma_g, \overline{\mathrm{F}}^{\mu}) & \xrightarrow{\beta\to\ 0} & (\mathcal{P}^{\mu} : \mu, \mu, \sigma_g, \mathsf{F}^{\mu}) \\
+\hat{1}\big\downarrow & & \big\downarrow +\hat{1} \\
(\overline{\mathcal{P}}^{\mu}_{\mathtt{princ}} : \mu, \mu, +1, \overline{\mathrm{F}}^{\mu}_{+}) & \xrightarrow[\beta\to 0]{} & (\mathcal{P}^{\mu}_{\mathtt{princ}} : \mu, \mu, +1, \mathsf{F}^{\mu}_{+}).
\end{array}$$

The set of all totally polarized particles is $\overline{\mathcal{P}}$, and its subset of only gravity polarized particles is $\overline{\mathcal{P}}^{\mu}$. The operation $\beta \to 0$ excludes the proto-charge polarization. Totaly polarized Planck particles $\overline{\mathcal{P}}^{\mu}$ are subset of the $\overline{\mathcal{P}}$, while only gravity polarized particles $\mathcal{P}^{\mu}$ are in the $\mathcal{P}$. The operator $\hat{\mu}$ reduces to the Planck particles and the operator $+\hat{1}$ reduces to the positive gravity sector.
We notice the extremal interaction mass $\mathfrak{M}_\star^2 = \overline{\mathsf{m}}_\sigma^2 \ln \mathsf{F}^*$ and the interaction mass of the Planck particle $\mathfrak{M}_{\mu_p}^2 = \overline{\mathsf{m}}_\sigma^2 \ln\ln \mathsf{F}^{\mu_p}$ differ in the structure functions $\mathsf{F}^* = \mu_p^2\, \Phi e^{-1}$ and $\mathsf{F}^{\mu_p} = \mu_p^2 1_{\mathrm{M}_o}^{-2} e^{-\Phi^{-1}}$. The extremal and the Planck particle have the same mass state variables when $\Phi = 1 \Leftrightarrow \beta = 0$ and $\sigma_g = 1$ Such particle is in the positive gravity sector, and $\mathsf{F}^* \equiv \mathsf{F}^{\mu_p} = \mu_p^2 1_{\mathrm{M}_o}^{-2}\, e^{-1} = \mathsf{F}_{\mathtt{fun}}$, and its structure-function is one of the Fundamental particles. Both the interaction charge and the interaction masses are proportional to the structure function F_{fun} and

$$\overline{\mathcal{Q}}_{fun}^2 = \mathrm{q}^2 \ln \mu_p^2\, e^{-1}, \quad \mathfrak{M}_{fun}^2 = \mu_p^2 \ln \mu_p^2\, e^{-1} \tag{P3}$$

0.9 Some Predictions

The mass solutions of the particle evolution equations are stored in the structural functions so that the mass implicit solution is in one of the structure functions. Hence, it is necessary to solve one of the evolution equations (D1.1, D2.1, D3.1)$for one of the \overline{\nu}$ or $\overline{\mathrm{F}}$ functions. We are solving the interaction charge equation (D1) for the structure-function $\overline{\mathrm{F}}$:

$$d_m\overline{\mathcal{Q}}^2 = q^2 d(\ln\overline{\mathrm{F}} = q^2 d\big(\ln m^2 1_{\mathrm{M}_o}^{-2} e^{-m^2\overline{\mathsf{m}}_\sigma^{-2}}\big) = \pm 2\mu_{\scriptscriptstyle B}\mathrm{C}^3\, d\tau, \qquad \text{(D1)}$$

$$\mathrm{q}^2\ln\overline{\mathrm{F}} \equiv \mathrm{q}^2\ln m^2 1_{\mathrm{M}_o}^{-2} e^{-m^2\overline{\mathsf{m}}_\sigma^{-2}} = \pm 2\mu_{\scriptscriptstyle B}\mathrm{C}^3\tau + C_\pm^q \qquad \text{(S1)}$$

$$\overline{\mathrm{F}} \equiv m^2 1_{\mathrm{M}_o}^{-2} e^{-m^2\overline{\mathsf{m}}_\sigma^{-2}} = e^{\pm 2\mu_{\scriptscriptstyle B}\mathrm{C}^3\mathrm{q}^{-2}\tau + C_\pm^q\mathrm{q}^{-2}}. \qquad \text{(S2)}$$

The following table presents the structure functions F of the polarized particles.

Table 2. Structure Function F of the Polarized Particles

	$\overline{\mathrm{F}}$	$\overline{\mathrm{F}}^{+1}$	$\overline{\mathrm{F}}^{\mu_p}$	$\overline{\mathrm{F}}_{+1}^{\mu_p}$
$\overline{\mathcal{P}}$	$m^2e^{-m^2\mu_p^{-2}\sigma_g(1-\beta^2)}$	$m^2e^{-m^2\mu_p^{-2}(1-\beta^2)}$	$\mu_p^2e^{-\sigma_g(1-\beta^2)}$	$\mu_p^2e^{-(1-\beta^2)}$
	F	F^{+1}	F^{μ_p}	$\mathsf{F}_{\mathsf{fun}}$
$\mathcal{P}$	$m^2e^{-m^2\mu_p^{-2}\sigma_g}$	$m^2e^{-m^2\mu_p^{-2}}$	$\mu_p^2e^{-\sigma_g}$	$\mu_p^2e^{-1}$

Solutions of the Mass Evolution Equations

To get some insight into the mass solutions of the particle evolution equations, we will look for the solutions of the equations (D1) and S1 specialized to the $(\mathcal{P}: m,\mu,\sigma_g = +1, \mathsf{F}^{+1})$ polarization class. At this place, it is convenient to rewrite F in the expanded form and

$$d_mQ^2 = d(\ln m^2 - m^2\mu_p^{-2}) = q^2 d\big(\ln m^2 1_{\mathrm{M}_o}^{-2} e^{-m^2\mu_p^{-2}}\big) = \ \pm 2\mu_{\scriptscriptstyle B}\mathrm{C}^3\, d\tau, \qquad \text{(D1')}$$

$$\mathsf{F} \quad \equiv m^2 1_{\mathrm{M}_o}^{-2} e^{-m^2\mu_p^{-2}} = \ln m^2 - m^2\mu_p^2 = f(\tau,\mathrm{q};\mu_{\scriptscriptstyle B}). \qquad \text{(S2')}$$

Two signs refer to the pair $(\Pi, \Pi*)$ particle and its dual/antiparticle particles.

1. Zero Proto Charge

The interchange of the charge between a particle and its neighborhood is zero, the mass factor $\mu_{\scriptscriptstyle B} = 0$, and the particle holds only by the electro-gravity interaction. The particle mass is the solution of the equation

$$\mathrm{q}^2 d\ln\mathsf{F} = 0 \;\;\Rightarrow\;\; \ln\mathsf{F} = const \;\;\Rightarrow\;\; \mathsf{F} = m^2 e^{-m^2/\mu_p^2} = \mathrm{C}$$

Integration constant C is bounded above by the maximum $e^{-1}\mu_p^2$ of the structure-function F at a mass $m^2 = \mu_p^2$, see Figure 1. For $0 \le \mathrm{C} \le e^{-1}\mu_p^2$ there is at least one mass solution. If we exclude the infinite mass solution and accept the Planck mass as a double solution, the particle must have two (m_1, m_2), $0 \le m_1^2 \le \mu_p^2 \le m_2^2 < \infty$ mass solutions.
The rest mass function F is universal in the sense that any particle mass is realized just on this function, and there is no other mass except those who obey the function F.

2. Electro Neutral Particle

Electro neutral particle, q = 0, is held only by the interaction of the gravity, and its evolution is described by the following simple differential equation

$$-\,\mathrm{g}\,m\,dm \pm \mu_{\scriptscriptstyle B}\mathrm{C}^3\,d\tau = 0 \;\;\Rightarrow\;\;\; m^2 = m_o^2 \mp \frac{2\mu_{\scriptscriptstyle B}\mathrm{C}^3}{\mathrm{g}}\,\tau.$$

The particle either accumulates or loses mass/ rest energy in the constant portions $\pm 2\mu_{\rm BC}{\rm c}^5{\rm g}^{-1}$ per unit of the time. The particle of a mass m_o decays in the $m_o^2{\rm g}/2\mu_{\rm B}{\rm c}^3$ seconds. The same time is needed to create a particle of the same mass,

3. Purely Charged Particle

Well defined particle excludes gravity only when the particle is massless. Thus, the purely charged particle is one of a mass very small compared to the Planck mass. For such particle

$$\frac{{\rm q}^2\,\dot m}{m} = \mp\,\mu_{\rm B}{\rm c}^3 \quad\Rightarrow\quad m = m_o e^{\mp\mu_{\rm B}{\rm c}^3{\rm q}^{-2}\,\tau}, \quad m_o \ll \mu_p.$$

Purely charged particles are either the mass-increasing or the mass-decreasing.

4. The Character of the Complete Mass Solution

An implicit solution of the evolution equation is the structure function by itself. Thus

$$\mathsf{F} \;= m^2 1_{\rm M_o}^{-2}\, e^{-m^2/\mu_p^2} = e^{\,C_\pm/{\rm q}^2}\, e^{\mp\,2\mu_{\rm B}{\rm c}^3\,\tau/{\rm q}^2} \;=\; \mathsf{A}^{\pm}\, e^{\mp\,2\mu_{\rm B}{\rm c}^3\,\tau/{\rm q}^2} \;\equiv\; f(\tau). \tag{S2.1}$$

We are showing that the structure-function achieves maximum $e^{-1}\mu_p^2$ at the mass $m = \overline{\mathsf{m}}_\sigma \sim \mu_p$. Else the function is zero at the zero mass and approaches zero at the infinite mass.

$$\begin{aligned} \mathsf{F}' &= e^{-m^2/\mu_p^2}\big(1 - m^2\mu_p^{-2}\big), & \mathsf{F}' = 0 \;\;&\Rightarrow\;\; m^2 = \mu_p^2 \\ \mathsf{F}'' &= -e^{-m^2/\mu_p^2}\big(2 - m^2\mu_p^{-2}\big)\mu_p^2, & \mathsf{F}''(\mu_p^2) < 0 &\Rightarrow F_{\max} = \mu_p^2 e^{-1}. \end{aligned}$$

Thus, the structure-function F achieves maximum at the Planck masses and

$$\mathsf{F}_\star = {\rm f}^2(\mu_p) = e^{-1}\mu_p^2 \quad\Rightarrow\quad e^{-1}\mu_p^2 \;\geq\; 1_{\rm M_o}^2\, e^{\,C_\pm/{\rm q}^2}\, e^{\mp\,2\mu_{\rm B}{\rm c}^3\,\tau/{\rm q}^2}.$$

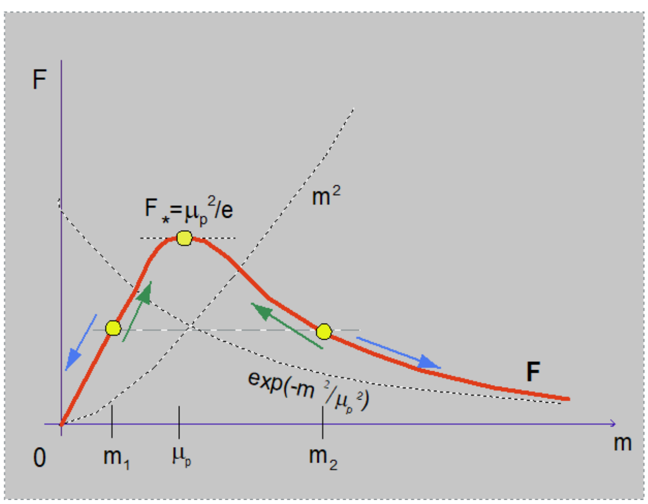

Figure 1: Universal Rest Mass/Energy Function

Corollary 0.16. *A particle of a finite mass either evolves into a Planck particle or a particle of the arbitrary large mass or decays into a particle of the* $\inf m$*. mass.*

$\square$ At each moment $\tau \geq 0$ the equation $\mathsf{F} = f(\tau) < \mathsf{F}_\star = f(\mathtt{T}^*)$ has the dual mass pair solutions $(m_1, m_2) : \inf m \leq m_1 \leq \mu_p \leq m_2 \leq \sup m$, Figure 1. We follow the particle on the graphic of its structure function F.
Each particle is the particle or dual particle before or after the Planck particle on the mass axes of the function F. If the particle is before the Planck particle dual particle, its time flows backward, and it decays into a particle of a mass $\inf m$. Else, the time takes physical direction, and the particle grows to the Planck particle. That implies that the increase of the particle time is bounded by the time $\mathtt{T}_*$ the particle needs to reach the top of the structure-function F.
The same analysis holds for the particles after Planck mass on the mass axes. ■

Universal Unit of the Mass

The universality of the Planck mass is that it participates in the formation of all particles, and the universality of the particle state variable functions are in that, that they are valid for the particles of all masses. Therefore, both statements hold on the class of the Planck particles in all polarisations, and in particular on the restriction to the class $(\mathcal{P}_{\mathsf{fun}} : \mu_\text{O}, \mu_{,\text{O}}, +1, 1)$ of the Fundamental Planck particles. The restriction to the Planck Fundamental particle class reduces the the structure-function $\mathsf{F} \to \mathsf{F}_{fun} = \mu_p^2 e^{-1} = \mathcal{Q}^2_{\mathtt{fun}} \text{q}^{-2}$ and the interaction charge equation (S1) to the

$$\mathcal{Q}^2_{\mathtt{fun}} = \text{q}^2 \ln(\mu_\text{O}^2 1_{\text{M}_o}^{-2} e^{-1}) = e^{\pm 2\mu_B \text{C}^3 \tau + C^q_\pm} \xrightarrow{\tau \to 0} e^{C^q_\pm} = \mathcal{Q}^2_\text{O} \in \mathbb{R} \tag{S1.2}$$

$$\Rightarrow \quad 1^2_{\text{M}_o} = \frac{\mu_\text{O}^2}{e} e^{-\text{q}^{-2} \mathsf{Q}^2_\text{O}} \tag{S1.3}$$

Consequently, the equation (S1.3) relates the Fundamental particle mass μ_O, the universal mass unit 1_{M_o} and an initial interaction charge $\mathcal{Q}_\text{O}$. Further specialization is given in the next definition.

Definition 0.17. *The Fundamental particle is the Maxwell electron* $\Pi_M \sim (\sqrt{\alpha}\mathtt{M}_{:2}, \text{E})$ *under electro interaction* $\text{q} : \text{q}^2 = \alpha\hbar\text{C}$.
The initial charge Q_O *is the charge* $\hbar\text{C}$ *of the Planck electron* $\Pi_p \sim (\mathtt{M}_{:2}, \text{E}_p)$ *distributed by the symmetry group* Z_2*. charge* $\text{E}_p = \sqrt{\hbar\text{C}}$*. Explicitly*

$$\mathsf{Q}^2_\text{O} = \mathbb{Z}_2\, \hbar\text{C} \sim |-\hbar\text{C},\, 0,\, +\hbar\text{C}\rangle.$$

Corollary 0.18. *The universal unit of the mass unit in the physical word supported by the fundamental Planck constants is* $1_{\text{M}_o} = \mathbf{0.565}\ [meV\text{C}^{-2}]$.

$\square$ By definition $\mu_\text{O} = \sqrt{\alpha}\mathtt{M}_{:2}$, is the reduced Planck mass constant $\mathtt{M}_{:2} = \mathtt{M}/2$, electric charge $\text{q} = \text{E}^2 = \alpha\hbar\text{C}, \alpha = 1/137$ and the initial charge a $\mathsf{Q}^2_\text{O} \sim \mathbb{Z}_2\, \hbar\text{C}$. Substitution to the equation (S1.3) leads to

$$1_{\text{M}_o} = \tfrac{\mu_\text{O}}{\sqrt{e}} e^{-\text{q}^{-1}\mathsf{Q}_\text{O}} = \tfrac{\sqrt{\alpha}\mathtt{M}_{:2}}{\sqrt{e}} e^{-\text{q}^{-2}\mathbb{Z}_2\, \hbar\text{C}} = \sqrt{\tfrac{\alpha}{e}}\, \mathtt{M}_{:2}\, e^{-((\alpha\hbar\text{C})^{-1}\mathbb{Z}_2\, \hbar\text{C}} = \sqrt{\tfrac{1}{137\, e}}\, \tfrac{2.18\cdot 10^{-5}}{2}\, e^{-\alpha^{-1}\mathbb{Z}_2}$$

$$\Rightarrow \qquad 1_{\text{M}_o} = 5.65 \cdot 10^{-7}\, e^{-\frac{137}{2} \cdot \left|1,0,-1\right\rangle} = \left|1.201 \cdot 10^{-36},\, 5.65 \cdot 10^{-7},\, 3.17 \cdot 10^{23}\right\rangle\ [\text{gr}]$$

$$1_{\text{M}_o} = \left|\mathbf{0.565},\ \mathbf{3.17} \cdot 10^{29},\ \mathbf{1.78} \cdot 10^{59}\right\rangle\ [\text{meV}\text{C}^{-2}].$$

The smallest mass $1_{\text{M}_o} = \mathbf{0.565}\,[\text{meV}\text{C}^{-2}]$, about half of the predicted mass $m_e = \mathbf{1.17}\,[\text{meV}\text{C}^{-2}]$ of the lightest , the electron neutrino [1] is the universal unit of the mass in the physical world supported by the universal Planck constants. ■

[1]R. Majkic, *Neutrino Mass Prediction, JHEPGC, Vol.10 No.4, August 29, 2024*

Conclusion

Physics is on an endless road to completion through the unification of concepts and theories while checking and testing its roots. This article builds a Physical model starting from the core of Physics to describe particle formation and to get glimpses into understanding and explaining possible origins of some crucial physical concepts like particle-antiparticle and gravity-antigravity concepts, and phenomena of the universe expansion and the origin of invisible matter etc.

Further work on verifying and developing the imposed ideas should be done. The quantization of the particle mass evolution equations should get the laws of the discretization of the particle masses.

Thanks for reading the paper
Radomir M.

Reference

[1] R. Majkic, *Neutrino Mass Prediction Journal of High Energy Physics, Gravitation and Cosmology Vol.10 No.4, August 29, 2024.*