Theory of Universal Origins

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We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at any certain moment would know all forces that set nature into motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit this data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.

~Pierre Simon Laplace.

Abstract:

We illustrate that by viewing gravity as the De Broglie wavelength of quantum mechanics, we are able to construct a working theory of quantum gravity. We also demonstrate that by replacing the inverse square law of Newton and Einstein by an exponential, we are capable of explaining the inconsistencies that lead to Dark Matter, as well as shedding some light on what transpired before the big bang.

Keywords: Quantum Gravity, Dark Matter, Dark Energy, Inflation, Before the Big Bang

Introduction

General Relativity has been extremely successful, and has provided some of the greatest insights in the history of physics but the theories of Quantum Field Theory (QFT) and Cosmology are leading us to question its validity;

- General Relativity's most integral idea is that space is malleable or deformable while QFT does not share this belief.
- This incompatibility means that scenarios such as the Big Bang where we need both General Relativity and QFT, then these scenarios are deemed to be theoretically unsolvable.
- General Relativity is in its very formulation expected to have severe complications. Because, it has no regard for the microscopic world – it is not built from the ground up (microscopic to macroscopic).
- In the cosmological arena unsolved problems such as dark energy, dark matter, and the inflation force seem to be gravitational in nature – an apparent breakdown of General Relativity.
- General Relativity is plagued by singularities that are an inherent property of its own equations
- General relativity yields unphysical solutions [37] such as the Taub-NUT solution, Ozsvath-schucking solution etc.
- The theory requires more than 95% of "dark entities" in order to describe observations

These are some of the reasons that have led many researchers into the pursuit of a new theory of gravity – The Quantum theory of Gravity. In the theory that we propose, we will see how from the most basic concepts of quantum mechanics, a theory of quantum gravity can emerge that has the power to not only be mathematically simpler than General Relativity but offer insights into the problems that are an integral part of general relativity

[General Relativity is like a mansion with two wings (the stress energy tensor and the geometry) one built with fine marble while the other is built with cheap wood] Albert Einstein

Perhaps contrary to popular belief, the cheap wood is the geometry side of Einstein's equation in favor of the flat space time of quantum field theory this is the view that we take in this paper.

Chapter 1: Universal Origins

Notation

Let

$$\frac{Ax}{y} = A_y^x \qquad or \qquad \frac{\gamma\Gamma hc}{\mu} = \Gamma_\mu^{\gamma hc}$$

Products and quotients serve as indices for simplification where ambiguity is evident

Space

We first define the space of our theory of quantum gravity, as the **Clifford $\mathbb{C}l$(1,3) space[1]** with the addition of **hyperreal numbers[36]**, as such, there exists a number **a**, such that

$$a^n = a = 1$$

And the definition of negative within this space is defined as

$$a + i^2 a = 0 \; and \; a + i^3 a = 2a$$

$$\mathrm{i}^2 = - \tag{1}$$

Thus i^2 is the mathematical definition of negative in physical Euclidean space.

More generally

$$i^2 \;=\; j^2 \;=\; k^2 \;=\; ijk \;=\; -$$

And

$$i^3 \;=\; j^3 \;=\; k^3 \;=\; ijk^2 \;=\; +$$

with inclusion of the spatial dimensions which are the quaternions of Hamilton[1]. Hence i is the definition of positivity and negativity in physical space. As such our space is the familiar Clifford space, with the quaternions to define the negatives and finally the inclusion of infinitesimal numbers – the hyperreals.

Consider the sequence

$$\mathrm{K} = \{k_1 = 0.1, k_2 = 0.01, k_3 = 0.001 \ldots\}, \qquad \text{where } \{n | n \in \mathbb{R}, k_n > 0\}$$

Using the transfer theorem to *ℝ, where *ℝ is the field of hyperreals, we find that in the limit

$$\lim_{n\to\infty} k_n = p \tag{2}$$

This means that

- **P is the smallest possible number before zero.**
- **P denotes a particle in physical space**

An object in this space is considered to be a particle, if it has dimensions of order p.

We also consider the series

$$\sum_{i=1}^{N} p_i = p + p + p + \cdots = a = 1$$

To determine the value of N, such that pN=1

$$S_n = \frac{n}{2}[2a + (n-1)d]$$

We find that $N = {}^{1}\!/_{p}$, let N = d, then

$$a = pd \quad \textit{where } d \neq \infty$$

<u>Properties of space:</u>

- Space does not interact with energy (matter) and vice versa.
- Space contains no energy.
- Space has size less than p at any volume in space i.e. the smallest spatial length of any object or particle must be greater or equal to p.
- The entropy of Space (S) is both zero and infinite.
- Infinite and invariant in three dimensions -- $\mathbb{C}l(t, \mathbb{R}^3)$ three dimensional extended Clifford space with energy/time being the Fourth dimension.
- Space has the inherent principle of nothingness.

<u>The Big Bang</u>

The major problem of the Big Bang Theory is explaining

What created the dense, high energy singularity? even if the theory were to successfully explain what caused this singularity, such as colliding branes or multi-universes[22], we are still left with an infinite number of questions of what created that and so on. The only way out of this conundrum is

- if and only if the universe created itself from nothing.

A true theory of the how the universe began should be able to describe everything we see from nothing. Mathematically we can write this as:

$$\Xi = \mathbb{R}^3 + \mathbb{O} \qquad \textit{where} \begin{cases} \Xi - \textit{Everything} \\ \mathbb{R}^3 - \textit{Euclidean Space} \\ \mathbb{O} - \textit{Nothing} \end{cases} \tag{3}$$

As we have seen earlier, space is not strictly Euclidean, but for simplicity we will denote space as $\mathbb{R}^3$. In order to describe this universe that emerges from nothing we first need to realize that

- our fundamental equations of physics diminish to nothing

i.e. describe nothing and that any of these equations can be added to $\Xi = \mathbb{R}^3 + \mathbb{O}$ without violating the laws of physics or mathematics; this is the essence of the nothingness property.

- $0 = g - \frac{GM}{r^2} = \mathbb{O}$
- $0 = (R_{\mu\nu} - {}^1/_2 R g_{\mu\nu}) - \frac{8\pi G}{c^4} T_{\mu\nu} = \mathbb{O}$
- $0 = i\hbar \frac{\partial}{\partial t}\Psi - \mathrm{H}\Psi = \mathbb{O}$

All these equations describe how matter and the field around it sum up to zero – nothing.

$$\Xi = \mathbb{R}^3 + \mathbb{O} = \mathbb{R}^3 + i\hbar\frac{\partial}{\partial t}\Psi - \mathrm{H}\Psi = \mathbb{R}^3 = \Xi$$

Weak nothingness property: The total energy of the particle(s) and generated wave (such as gravity) is zero.

$$Total\ energy\ of\ particle + Total\ enrgy\ of\ the\ particles\ wave = 0$$

i.e. mass + gravity produced = 0

Strong nothingness property: The total sum of everything in the universe is zero

The nothingness property allows for two or more particles, such as the electron and positron to exist in this space… so long as the total sum of all quantities is zero

Such as

- Opposite charge $q_{proton} + q_{electron}$ = (e + (-e)=$\mathbb{O}$)
- Spin of electron and positron summing to zero

N.B! Entangled particles are simply a consequence of the nothingness property; the sum total of all properties is always zero.

Below we will summarize the events that occurred in the Big Bang:

I. $\Xi = \mathbb{R}^3$ (*In the beginning everything was just space*)
II. $\Xi = \mathbb{R}^3 + \mathbb{O}$ (*In the beginning there was space and Nothing $\mathbb{O}$*), but

$(Total\ Energy\ of\ the\ wave\ \mathcal{E}) + (Total\ Energy\ of\ Particle(s)\ E) = \mathbb{O}$

$$\mathbb{O} = -g + \frac{GM}{r^2} = -i\hbar\frac{\partial}{\partial t}\Psi + \mathrm{H}\Psi = -G_{\mu\nu} + \frac{8\pi G}{c^4}T_{\mu\nu} = \mathbb{O}$$

This allows any particle to emerge from empty space, as long as its total energy (mass, charge etc.) is not less or greater but exactly equal but opposite to its wave; gravity, electromagnetism, etc. So the total sum of mass and gravity for example is always zero.

$\therefore \quad \varXi = \mathbb{R}^3 + (Total\ Energy\ of\ the\ wave\ \mathcal{E}) + (Total\ Energy\ of\ Particle(s)\ E)$

$$\varXi = \mathbb{R}^3 + \left(\sum_i^N \mathcal{E}_i + \sum_i^N E_i\right), \qquad where\ N < \infty \tag{4}$$

$$\varXi = \mathbb{R}^3 + \mathbb{0} = \mathbb{R}^3 + \left(i\hbar \frac{\partial}{\partial t}\Psi - \mathrm{H}\Psi\right)$$

The big bang

- When our universe began all fundamental quarks (pentaquarks)/gluons emerged from this fabric of space with their antiparticles at the same position in physical space (close enough to interact with each other) and at the same time (a handful of particles). At this interaction of particles, all intrinsic properties, such as color, charge, energy etc. is zero i.e. nothing. This interaction is necessary for the particles to interact and form composite particles such as protons, etc. instead of annihilating with their antiparticles back into nothing.

$$\left(\sum \mathcal{E}_{i,quarks} + \sum E_{i,quarks}\right) = \mathbb{0}$$

- Everything that emerges from the fabric of space emerges with its own laws and constants that fully describe its behavior and interaction in $\mathbb{R}^3$, such as the speed of light (how fast its photons move), $A = \pi r^2$, etc.
- We specifically said that these handful of quacks emerged at the same position and time, as such by Heisenberg's Uncertainties[] they will not have a well define momentum(P) and Energy (E), this undefined energy and momentum is the monumental surge of energy we observe in the Big Bang.
- By $E = mc^2$ this huge energy turns the handful of particles into all the particles in the universe by the conversion of energy into matter.
- With energy being directly proportional to temperature, A huge amount of energy meant a monumental amount of temperature.
- The universe evolved to a time explainable by the standard model of the Big Bang.

Conclusion and Final Remarks: To believe that this improbable, but possible event happened once and only once would be a fool's hope of centralizing his own existence. Similar to the ancient's of the geocentric model or a shell fish blindly stuck to a rock, not realizing the vastness of the sea. I have strong convictions that our universe cannot be the only universe that has been able to evolve in this manner. Although such universes would be mind blowingly different, harboring different sets of laws and constants and fundamental shapes that emerged at their respective Big Bangs. The interactions of such universes would still be determined from our equation of everything.

$$\varXi = \mathbb{R}^3 + L = \mathbb{R}^3 + \left(\sum_i^N \mathcal{E}_i + \sum_i^N E_i\right) - \left(\sum_i^M \mathcal{E}_i + \sum_i^M E_i\right), \qquad where\ N, M < \infty$$

where L is the Lagrangian, or trajectory of the universes, although the physics would be quite different. If one agrees with my line of thought, and agrees that particles / universes can emerge from nothing... allow me to elaborate further that the big bang (the birth of a universe) is an extremely rare occasion, but imagine an absolutely rare occasion still, whereby not simply an innate object emerges from space, but a conscious 'being' emerging. The laws of physics agree with this idea of a super being emerging from the realm of space although this is the most rare form of emergence. Much can be said about these universes that are embedded in this truly magnificently infinite multiversed space, and the possibility of a conscious being, that unlike us was not born but emerged, but as our knowledge about this complexity emerges, our narrow, pinhole view of the laws of physics seem to be approaching ever more closer *to the mind of God*.

Chapter 2: Quantum Gravity

Let the Hamiltonian H of quantum gravity, in $\mathbb{C}l(\tau,*\,\mathbb{R}^3)$ with extensions of hyperreals be.

$$\mathrm{H} = H_0 e_0 + H_1 e_1 + H_2 e_2 + H_3 e_3 \tag{5}$$

Where

$$\left| \begin{aligned} e_0 &= c\hat{t} \\ e_1 &= \hat{x} \\ e_2 &= \hat{y} \\ e_3 &= \hat{z} \end{aligned} \right. \qquad \text{and} \qquad \left| \begin{gathered} \hat{y}\hat{z} = \hat{\imath} \\ \hat{x}\hat{z} = \hat{\jmath} \\ \hat{x}\hat{y} = \hat{k} \\ \hat{x}^2 = \hat{y}^2 = \hat{z}^2 = -1 \end{gathered} \right.$$

$$H = H_\mu e_\mu = cH_t\hat{t} + H_x\hat{x} + H_y\hat{y} + H_z\hat{z}$$

Where the Greek indices $H_\mu e_\mu$ is summed over the usual 'Einstein Summation Convention'

The invertibility[1] in Clifford algebra is extremely important as such for non-invertibility, we have

$$\det(H) = 0$$

$$c^2 H_t^2 - H_x^2 - H_y^2 - H_z^2 = 0 \tag{6}$$

This corresponds to the invariant in relativity [2]. Let's consider this Hamiltonian in Schrodinger's equation.

$$i\hbar \frac{\partial}{\partial t}\Psi = H_{QG}\Psi$$

Where H_{QG} is the Hamiltonian that describes Quantum Gravity, in matrix form we have

$$i\hbar \frac{\partial}{\partial t} \begin{bmatrix} \Psi_1 \\ \Psi_2 \\ \Psi_3 \\ \Psi_4 \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} & H_{13} & H_{14} \\ H_{21} & H_{22} & H_{23} & H_{24} \\ H_{31} & H_{32} & H_{33} & H_{34} \\ H_{41} & H_{42} & H_{43} & H_{44} \end{bmatrix} \begin{bmatrix} \Psi_1 \\ \Psi_2 \\ \Psi_3 \\ \Psi_4 \end{bmatrix}$$

The general solution for this equation, will be of the form postulated by Dirac [10] $e^{-\frac{i}{\hbar}I}$ and later refined by Feynman [10],in the path integral formulation.

$$\Psi(x^{\mu}) = \Psi_0(x^{\mu})e^{\frac{-i}{\hbar}(p^{\mu}x^{\mu}-Et)}$$

These plane waves describe how fundamental waves, such as gravity propagating from the source.

If we first find the inverse Fourier transform of Planck's relation $E = hf$,

$$\int_0^{\infty} f(s)e^{-2\pi nst}ds = \int_0^{\infty} hse^{-2\pi nst}ds$$

We find

$$\tau E = nh \qquad where\, n \geq 1 \tag{7}$$

$$\tau E = h \qquad for\, n = 1$$

We can write the general product of time and energy

$$(Time)(Energy = \begin{Bmatrix} \tau E = h & for\; t \to \infty\; (many\; particles\; - Quantum\; Gravity) \\ \Delta t \Delta E = \dfrac{h}{4\pi} & for\; t \to 0\; (few\; particles - Quantum\; Mechanics) \end{Bmatrix}$$

The Hamiltonian of Quantum gravity dynamics, as opposed to that of Quantum Electrodynamics or quantum chromodynamics will have the following terms;

By studying an ensemble of particles in space, we realize that the defining factors of gravity will be the density (ρ) of the ensemble, the linear (p) and angular (L) momenta, the temperature (T) and the generalized pressure (P).

Density: density as opposed to mass requires that (two masses separated by light year distances do not have the same summed gravitational effect as two masses in close proximity)

Linear and Angular Momenta: By relativity motion 'adds more mass' to an ensemble as such generates more gravity

Generalized Pressure: The pressure acts as an external force to the ensemble affecting momenta, density, etc. as we observe in the evolution of stars. We can add the stress and strain to this generalized pressure.

Temperature (*T*): The temperature will affect the kinetic energy of the constituencies of the ensemble, this increase/decrease in relativistic mass will affect the gravity

N.B! The general form of the source will be approximate to that of the stress energy tensor with units of energy.

$$H_{QG} = (c^2 \int \rho d^3 r + k_b T)\, e_\tau + c \sum_{i=1}^{3} (P_i + \vartheta p_i + \xi L_i) e_i \tag{8}$$

$$where \begin{cases} \rho \text{ is the density} \\ P \text{ is the momentum} \\ p \text{ is the pressure} \\ L \text{ is the angular momentum} \\ T \text{ is the temperature} \\ \vartheta \text{ is the pressure multiplication term} \\ \xi \text{ is the angularmomentum multiplication term} \end{cases}$$

This reduces to Dirac equation in few particle dynamics[]

$$H_{QG} = mc^2 e_\tau + \sum_{i=1}^{3} P_i e_i = \gamma^0 mc^2 + \ c \sum_{i=1}^{3} P_i \alpha_i \tag{9}$$

Where $\gamma^0$and α_i are the Dirac Matrices[34], which signify that the total energy of a single particle will be due to its mass and momentum in space, as such the energy of the wave will be equal to this. In order to solve this equation in a form suitable for gravity,

$$\Psi = \Psi_0 e^{\frac{-i}{\hbar}(px - Et)}$$

We redefine the wavefunction in terms of a more familiar variable

The Quantum – Classical Connection

This equation is vastly important, as it defines the wavefunction for a many particle system suitable for gravity. A similar equation is realized in the WKB approximation [31]

$$\Psi = \frac{\varepsilon}{\sqrt{\lambda}} \tag{10}$$

or

$$[\Psi(x^\mu)]^2 = h\varepsilon P(x^\mu)$$

POSTULATE: The WKB Method can be regarded here as quantitative way of describing the Law of Large Numbers (LLN) [21], although for a few particles it is only an approximation method used in varied fields such as quantum mechanics and cosmology [31]. For a large enough ensemble of particles the approximation becomes exact being suitable for a study in gravity. This is the link between the very small and the very large.

Using the De Broglie relation

$$E = E_0 e^{\frac{-2i}{\hbar}(px-Et)}$$

$$E = \gamma mc^2 e^{\frac{-2i}{\hbar}(px-Et)}$$

Thus

$$P(x^\mu) = P_0(x^\mu) e^{\frac{-2i}{\hbar}(p^\mu x^\mu - Et)}$$

The non-moving body

$$i\hbar \frac{\partial}{\partial t} \Psi = H_{QG} \Psi$$

$$H_{QG} = (c^2 \int \rho d^3 r + k_b T)\, e_\tau + c \sum_{i=1}^{3} (P_i + \vartheta p_i + \xi L_i) e_i$$

$$H_{QG} = c^2 \int \rho d^3 r\, e_\tau = \gamma^0 c^2 \int \rho d^3 r$$

$$i\hbar \frac{\partial}{\partial t} \begin{bmatrix} \Psi_1 \\ \Psi_2 \\ \Psi_3 \\ \Psi_4 \end{bmatrix} = \begin{bmatrix} c^2 \int \rho d^3 r & 0 & 0 & 0 \\ 0 & c^2 \int \rho d^3 r & 0 & 0 \\ 0 & 0 & -c^2 \int \rho d^3 r & 0 \\ 0 & 0 & 0 & -c^2 \int \rho d^3 r \end{bmatrix} \begin{bmatrix} \Psi_1 \\ \Psi_2 \\ \Psi_3 \\ \Psi_4 \end{bmatrix}$$

$$\Psi = \Psi_0 e^{\frac{-i}{\hbar}(px-Et)}$$

We can write this in Mat (2,ℝ)[1] and find the determinant

The moving body

$$i\hbar \frac{\partial}{\partial t} \Psi = H_{QG} \Psi$$

$$H_{QG} = c^2 \int \rho d^3 r\, e_\tau + c \sum_{i=1}^{3} P_i e_i$$

$$H_{QG} = \gamma^0 c^2 \int \rho d^3 r + c \sum_{i=1}^{3} P_i \gamma^i \; = \gamma^0 \left[c^2 \int \rho d^3 r + c P_1 \gamma^1 + P_2 \gamma^2 + P_3 \gamma^3 \right]$$

where

$$\gamma^0 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}, \gamma^1 = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}, \gamma^2 = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}, \gamma^3 = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & 0 \end{bmatrix}$$

Such that

$$\gamma^0, \gamma^1 = -2\eta^{01} I_4$$

$$H_{QG} = \begin{bmatrix} c^2 \int \rho d^3 r & 0 & 0 & 0 \\ 0 & c^2 \int \rho d^3 r & 0 & 0 \\ 0 & 0 & -c^2 \int \rho d^3 r & 0 \\ 0 & 0 & 0 & -c^2 \int \rho d^3 r \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & cp_1 \\ 0 & 0 & cp_1 & 0 \\ 0 & cp_1 & 0 & 0 \\ -cp_1 & 0 & 0 & 0 \end{bmatrix}$$
$$+ \begin{bmatrix} 0 & 0 & 0 & cp_2 \\ 0 & 0 & cp_2 & 0 \\ 0 & cp_2 & 0 & 0 \\ cp_2 & 0 & 0 & 0 \end{bmatrix} + \begin{bmatrix} 0 & 0 & cp_3 & 0 \\ 0 & 0 & 0 & cp_3 \\ cp_3 & 0 & 0 & 0 \\ 0 & -cp_3 & 0 & 0 \end{bmatrix}$$

∴

$$i\hbar \frac{\partial}{\partial t} \begin{bmatrix} \Psi_1 \\ \Psi_2 \\ \Psi_3 \\ \Psi_4 \end{bmatrix} = \begin{bmatrix} c^2 \int \rho d^3 r & 0 & cp_3 & cp_1 + cp_2 \\ 0 & c^2 \int \rho d^3 r & cp_1 + cp_2 & -cp_3 \\ cp_3 & cp_1 + cp_2 & -c^2 \int \rho d^3 r & 0 \\ -cp_1 + cp_2 & -cp_3 & 0 & -c^2 \int \rho d^3 r \end{bmatrix} \begin{bmatrix} \Psi_1 \\ \Psi_2 \\ \Psi_3 \\ \Psi_4 \end{bmatrix}$$

The solution will be of the form

$$\Psi = \Psi_0 e^{\frac{-i}{\hbar}(px - Et)}$$

$$[\Psi(x^\mu)]^2 = h\varepsilon P(x^\mu)$$

$$\sqrt{h\varepsilon P(x^\mu)} = \sqrt{h\varepsilon P_0(x^\mu)} e^{\frac{-i}{\hbar}(px - Et)}$$

$$P(x^\mu) = \begin{bmatrix} E/c \\ P_x \\ P_y \\ P_z \end{bmatrix} e^{\frac{-2i}{\hbar}(px - Et)}$$

Or

$$E = c\begin{bmatrix} E/_c \\ P_x \\ P_y \\ P_z \end{bmatrix} e^{\frac{-2i}{\hbar}(px-Et)}$$

$$F(x^{\mu}) = \frac{\partial E}{\partial t} = -\frac{2iE}{\hbar}\begin{bmatrix} E/_c \\ P_x \\ P_y \\ P_z \end{bmatrix} e^{\frac{-2i}{\hbar}(px-Et)} \tag{11}$$

Chapter 3: Quantum Gravity Dynamics

Action in Physics

The action in physics is understood to be a functional with no inherent meaning on its own [10], in this text we elucidate more on the fundamental meaning of the action. In standard texts, $\delta I = 0$, the Hamiltonian principle and $I = \int L(q, \dot{q})dt$.

Under constant L,

$$I = \int L(q, \dot{q})dt = \int_{t}^{t+\Delta t} (E - \mathcal{E})\Delta t = \Delta E \Delta t$$

We then realize that the action has the form

$$I = \tau E \quad or \quad I = \lambda p \tag{12}$$

Where τ, is the quantum of time, from $\tau E = h$ as derived from taking the Fourier transform of Planck's equation $E = hf$.

$$I = \tau E \qquad \therefore I = nh, \;\; where\; n \geq 1 \tag{13}$$

With this definition we realize that the standard derivation of the **Euler-Lagrange Equations** is given a deeper theoretical meaning.

$$\delta I = \int_{t_1}^{t_2} \left(\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_\alpha} - \frac{\partial L}{\partial q_\alpha}\right)\beta(t)dt = \delta(nh)$$

But, $\delta I = \delta(nh) = 0$, since (nh) is a constant. We thus realize that $\tau E = h$ is the necessary condition needed for the E-L equations.

$$I = \begin{Bmatrix} \tau E = h & many\ particles \\ \Delta t \Delta E \approx h & few\ paritcles \end{Bmatrix} \quad \text{and} \quad I = \begin{Bmatrix} \lambda p = h & many\ paricles \\ \Delta x \Delta p \approx h & few\ particles \end{Bmatrix}$$

The particle Case – treating the body as a single particle

The Space-like domain

Newtonian Approximation

- Gravity becomes precisely defined when the uncertainty of the Shwarzchild radius (R_s) $\Delta R_s \Delta p \geq \frac{\hbar}{2}$ has a definite value, such that $R_s = \frac{2GM}{c^2}$
- The gravitational wave/field of a body acts as if all the mass is concentrated at the real/fictitious black hole of that object with Schwarzchild radius $R_s = \frac{2GM}{c^2}$

$$i\hbar \frac{\partial}{\partial t}\Psi = H_{QG}\Psi$$

$$H_{QG} = (c^2 \int \rho d^3 r + k_b T)\, e_\tau + c\sum_{i=1}^{3}(P_i + \vartheta p_i + \xi L_i)e_i$$

$$E = c\begin{bmatrix} E/c \\ P_x \\ P_y \\ P_z \end{bmatrix} e^{\frac{-2i}{\hbar}(px-Et)}$$

In the Newtonian approximation, we will have

$$E = \gamma mc^2 e^{-\frac{2i}{\hbar}(px-Et)}$$

Or

$$E = \frac{\gamma^{mc^2}}{e^{\frac{2i}{\hbar}(px-Et)}}$$

Finding the Taylor polynomial of $e^{\frac{2i}{\hbar}(px-Et)}$

The Taylor polynomial

$$f(x) = e^{-2i\left(\frac{mc}{\hbar}\right)x} f(x) = \sum_{n=o}^{\infty} \frac{f^n(0)}{n!}x^n = 1 + \frac{2i(\frac{mc}{\hbar})}{1!}x + \frac{(-4(\frac{mc}{\hbar})^2)}{2!}x^2$$

$$Re[f(x)] = e^{-2i\left(\frac{mc}{\hbar}\right)x} f(x) = \sum_{n=o}^{\infty} \frac{f^n(0)}{n!}x^n = 1 + \frac{(-4(\frac{mc}{\hbar})^2)}{2!}x^2$$

$$E = \frac{\gamma mc^2}{1 + \frac{(-4(\frac{mc}{\hbar})^2)}{2!}x^2}$$

$$E \approx \frac{\gamma mc^2}{1} + \frac{\gamma mc^2}{\frac{(-4(\frac{mc}{\hbar})^2)}{2!}x^2}$$

$$E = \gamma mc^2 - \frac{\gamma \hbar^2}{2mx^2}$$

$$F_1 = \frac{dE_1}{dx} = \frac{\gamma mc^2}{x} \qquad and \qquad F_2 = \frac{dE_2}{dx} \approx -\frac{\gamma \hbar^2}{2mx^3}$$

Using the condition (where the two could have been removed from the Taylor):

$$r = r_s = \frac{GM}{c^2}$$

∴

$$F_1 = \frac{dE_1}{dx} = \frac{GMm}{x^2} \qquad and \qquad F_2 = \frac{dE_2}{dx} = -\frac{\gamma \hbar^2 c^2}{2GMmx^2} \tag{14}$$

N.B! only the real solutions correspond to physical reality.

Dark Matter:

The Imaginary part

$$Im[f(x)] = \frac{2i\alpha}{1!}x + \frac{(-8i\alpha^3)}{3!}x^3 + \frac{32i\alpha^5}{5!}x^5 + \frac{(-128\alpha^7)}{7!}x^7 + \frac{512i\alpha^9}{9!}x^9 + \frac{(-2048i\alpha^{11})}{11!}x^{11} + \frac{8192i\alpha^{13}}{13!}x^{13} + O(x^{15})$$

$$F(x) = \frac{dE}{dx} = -2i\gamma m^2c^3 e^{-2i/_{\hbar}(mcx)}$$

Assuming positive E, we have

$$F(x) = \frac{2i\gamma m^2c^3/\hbar}{\frac{2i\alpha}{1!}x + \frac{8i\alpha^3}{3!}x^3 + \frac{32i\alpha^5}{5!}x^5 + \frac{128\alpha^7}{7!}x^7 + \frac{512i\alpha^9}{9!}x^9 + \frac{2048i\alpha^{11}}{11!}x^{11} + O(x^{13})}$$

At solar system/ Einstein scales, we will neglect higher ordered terms

$$F(x) \approx \frac{2i\gamma m^2c^3}{\frac{2imc}{\hbar}\hbar x} = \frac{\gamma mc^2}{x}$$

If we use the idea that the gravitational wave/field of a body acts as if all the mass is concentrated at the real/fictitious black hole of that object with Schwarzchild radius $R_s = \frac{2GM}{c^2}$, then

$$F(x) = \frac{GMmc^2}{x^2}$$

Where $\gamma \to 1$ and the extra two can be absorbed into the denominator.

If we move further to larger radii,

$$F(x) \approx \frac{2i\gamma m^2 c^3/\hbar}{\frac{8i\alpha^3}{3!}x^3 + \frac{32i\alpha^5}{5!}x^5} = \frac{2\gamma m^2 c^3/\hbar}{\frac{8\alpha x}{3!}(\alpha^2 x^2 + \frac{4\alpha^4}{5!}x^4)}$$

Using the fact that

$$\frac{\Omega}{xz} = \frac{\Omega}{x} + \frac{\Gamma\Omega}{z} \qquad where \quad \Gamma = \frac{1-z}{x}$$

We have

$$F(x) \approx \frac{\frac{2i\gamma m^2 c^3}{\hbar}}{\frac{8i\alpha^3}{3!}x^3 + \frac{32i\alpha^5}{5!}x^5} = \frac{\frac{2\gamma m^2 c^3}{\hbar}}{\frac{8\alpha x}{3!}} + \frac{\frac{\Gamma 2\gamma m^2 c^3}{\hbar}}{\alpha^2 x^2 + \frac{4\alpha^4}{5!}x^4} \approx \frac{\frac{2\gamma m^2 c^3}{\hbar}}{\frac{8\alpha x}{3!}} = \frac{3\gamma mc^2}{2x} = \frac{3GMm}{2x^2}$$

∴

$$F(x) = \frac{GMm}{x^2} + \frac{3GMm}{2x^2} + \frac{15GMm}{2x^2} \dots$$

$$V(r) = \frac{\frac{Gm}{r}}{\sum \Pi_i} = \frac{Gm}{r}\left(\sum \Pi_i\right)^{-1} = \frac{Gm}{r}\sum \hat{\Pi}_i \tag{15}$$

$$\hat{\Pi}_i = 1 + \frac{3}{2} + \frac{15}{2} + \cdots$$

The series converges at large enough radii

$$V(r) = \frac{Gm}{r} \qquad Newtonian/Einstein\ Regime$$
$$V(r) = \frac{Gm}{r} + \frac{3}{2}\frac{Gm}{r} = 2.5\frac{Gm}{r} \quad first\ Einstein\ correction\ \delta^1(N)$$
$$\therefore \quad V(r) = 10\frac{Gm}{r} \quad second\ Einstein\ Correction\ \delta^2(N)$$
$$\vdots$$
$$\Omega\ \frac{Gm}{r} \quad The\ last\ Einstein\ correction\ \ \Omega = 1 + \frac{2^4}{4!} + \sum_{n=6}^{N}\left(\frac{4}{n^2+3n+2}\right)$$
$$\frac{Gm}{r}\sum \hat{\Pi}_i$$

Newtonian/Einstein Gravity is only valid for certain distances from the object, as we move further and further away from the object, the Einstein corrections are required.

The Real Part

$$f(x) = \sum_{n=o}^{\infty} \frac{f^n(0)}{n!} x^n$$

$$= 1 + \frac{2i\alpha}{1!}x + \frac{(-4\alpha^2)}{2!}x^2 + \frac{8i\alpha^3}{3!}x^3 + \frac{16\alpha^4}{4!}x^4 + \frac{32i\alpha^5}{5!}x^5 + \frac{(-64\alpha^6)}{6!}x^6 + \frac{(-128\alpha^7)}{7!}x^7 + \frac{256\alpha^8}{8!}x^8 + \frac{512i\alpha^9}{9!}x^9 + \frac{(-1024\alpha^{10})}{10!}x^{10} + \frac{(-2048i\alpha^{11})}{11!}x^{11} + \frac{4096\alpha^{12}}{12!}x^{12} + \frac{8192i\alpha^{13}}{13!}x^{13} + \frac{(-16384\alpha^{14})}{14!}x^{14}$$

Taking the real part

$$Re[f(x)] = 1 + \frac{(-4\alpha^2)}{2!}x^2 + \frac{16\alpha^4}{4!}x^4 + \frac{(-64\alpha^6)}{6!}x^6 + \frac{256\alpha^8}{8!}x^8 + \frac{(-1024\alpha^{10})}{10!}x^{10} + \frac{4096\alpha^{12}}{12!}x^{12} + \frac{(-16384\alpha^{14})}{14!}x^{14} + O(x^{16})$$

Similarly for the imaginary part

$$Im[f(x)] = \frac{2i\alpha}{1!}x + \frac{8i\alpha^3}{3!}x^3 + \frac{32i\alpha^5}{5!}x^5 + \frac{(-128\alpha^7)}{7!}x^7 + \frac{512i\alpha^9}{9!}x^9 + \frac{(-2048i\alpha^{11})}{11!}x^{11} + \frac{8192i\alpha^{13}}{13!}x^{13} + O(x^{15})$$

Now given a random Ω

$$\mathrm{K}(x) = \frac{\Omega}{Re[f(x)]}$$

$$\mathrm{K}(x) \approx \frac{\Omega}{\frac{(-4\alpha^2)}{2!}x^2 + \frac{16\alpha^4}{4!}x^4 + \frac{(-64\alpha^6)}{6!}x^6 + \frac{256\alpha^8}{8!}x^8 + \frac{(-1024\alpha^{10})}{10!}x^{10} + \frac{4096\alpha^{12}}{12!}x^{12} + \frac{(-16384\alpha^{14})}{14!}x^{14}}$$

But, $\frac{\Omega}{xz} = \frac{\Omega}{x} + \frac{\Gamma\Omega}{z}$ *where* $\Gamma = \frac{1-z}{x}$ Thus,

$$\mathrm{K}(x) = \frac{\Omega}{\alpha^2 x^2} + \frac{\Gamma\Omega}{[-2 + \frac{16\alpha^2}{4!}x^2 + \frac{(-64\alpha^4)}{6!}x^4 + \frac{256\alpha^6}{8!}x^6 + \frac{(-1024\alpha^8)}{10!}x^8 + \frac{4096\alpha^{10}}{12!}x^{10} + \frac{(-16384\alpha^{12})}{14!}x^{12}]}$$

Where

$$\Gamma = \frac{-\frac{16\alpha^2}{4!}x^2 - \frac{(-64\alpha^4)}{6!}x^4 - \frac{256\alpha^6}{8!}x^6 - \frac{(-1024\alpha^8)}{10!}x^8 - \frac{4096\alpha^{10}}{12!}x^{10} - \frac{(-16384\alpha^{12})}{14!}x^{12}}{\alpha^2 x^2}$$

hence

$$\mathrm{K}(x) = \frac{\Omega}{\alpha^2x^2} + \frac{\Omega\left[\frac{-\frac{16\alpha^2}{4!}x^2 - \frac{(-64\alpha^4)}{6!}x^4 - \frac{256\alpha^6}{8!}x^6 - \frac{(-1024\alpha^8)}{10!}x^8 - \frac{4096\alpha^{10}}{12!}x^{10} - \frac{(-16384\alpha^{12})}{14!}x^{12}}{\alpha^2 x^2}\right]}{[-2 + \frac{16\alpha^2}{4!}x^2 + \frac{(-64\alpha^4)}{6!}x^4 + \frac{256\alpha^6}{8!}x^6 + \frac{(-1024\alpha^8)}{10!}x^8 + \frac{4096\alpha^{10}}{12!}x^{10} + \frac{(-16384\alpha^{12})}{14!}x^{12}]}$$

$$\mathrm{K}(x) = \frac{\Omega}{\alpha^2x^2} + \frac{\Omega}{\frac{2^4}{4!}\alpha^2x^2} + \frac{\Gamma\Omega}{1 \ + \ \frac{2^2}{6!/4!}\alpha^2x^2 \ + \ \frac{2^4}{8!/4!}\alpha^4x^4 + \ldots + \frac{2n-4}{n!/4!}\ \alpha^{n-2}x^{n-2}}$$

$$\mathrm{K}(x) = \frac{\Omega}{\alpha^2x^2} + \frac{\Omega}{\frac{2^4}{4!}\alpha^2x^2} + \frac{\Omega}{\frac{2^2}{6!/4!}\alpha^2x^2} + \frac{\Omega}{\frac{2^4}{8!/4!}\alpha^4x^2} + \cdots + \frac{\Omega}{\frac{2^2}{n!/(n-2)!}\ \alpha^{(n-2)-2}x^{(n-2)-2}}$$

∴

$$\mathrm{K}(x) = \frac{\Omega}{\alpha^2x^2} + \frac{\Omega}{\frac{2^4}{4!}\alpha^2x^2} + \frac{\Omega}{\frac{2^2}{6!/4!}\alpha^2x^2} + \frac{\Omega}{\frac{2^4}{8!/4!}\alpha^4x^2} + \cdots + \frac{\Omega}{\frac{2^2}{n!/(n-2)!}\ \alpha^{(n-2)-2}x^{(n-2)-2}}$$

The term preceding becomes applicable after making the assumption that we are moving further and further from the object.

$$\mathrm{K}(x) = \frac{\Omega}{\alpha^2x^2} + \frac{{}^2/_3\,\Omega}{\alpha^2x^2} + \frac{{}^4/_9\,\Omega}{\alpha^2x^2} + \Phi + \chi + \chi_1$$

$$\sum \Pi_i = \left[1 + \frac{2^4}{4!} + \lim_{n\to\infty}\sum_{n=6}^{N}\left(\frac{4}{n^2+3n+2}\right)\right]$$

Such that

$$|\Pi_1 = 1$$

$$|\Pi_1 = \frac{2^4}{4!}$$

$$\vdots$$

$$|\Pi_n = \sum_{n=6}^{N}\left(\frac{4}{n^2+3n+2}\right)^{i^n}$$

Trajectory of a non-relativistic particle:

Now

$$L = E - \varepsilon = Energy\ of\ particle(s) - External\ energy\ on\ particle(s)$$

$$L = {}^{1}\!/_{2}\, m\dot{x}^2 - \gamma mc^2 e^{-2i\left(\frac{mc}{\hbar}\right)x}$$

Hence

$$\frac{\partial L}{\partial \dot{x}} = m\dot{x} \quad and \quad \frac{\partial L}{\partial x} = \frac{4i\gamma m^2c^3}{\hbar} e^{-2i\left(\frac{mc}{\hbar}\right)x}$$

The Taylor polynomial of $f(x) = e^{-2i\left(\frac{mc}{\hbar}\right)x}$

$$\sum_{n=o}^{\infty} \frac{f^n(0)}{n!} x^n = 1 + 2i\left(\frac{mc}{\hbar}\right)x - 2\left(\frac{mc}{\hbar}\right)^2 x^2 - \frac{4i}{3}\left(\frac{mc}{\hbar}\right)^3 x^3 + O(x^4)$$

From our equations of motion

$$\frac{d}{dt}\frac{\partial L}{\partial \dot{q}_\alpha} - \frac{\partial L}{\partial q_\alpha} = 0$$

We have

$$\frac{d}{dt}(m\dot{x}) - \frac{4i\gamma m^2c^3}{\hbar} e^{-2i\left(\frac{mc}{\hbar}\right)x} = 0$$

$$\frac{d}{dt}(m\dot{x}) - \frac{\frac{4i\gamma m^2c^3}{\hbar}}{1 + 2i\left(\frac{mc}{\hbar}\right)x - 2\left(\frac{mc}{\hbar}\right)^2 x^2 - \frac{4i}{3}\left(\frac{mc}{\hbar}\right)^3 x^3 + O(x^4)} = 0$$

$$m\ddot{x} = \frac{\frac{4i\gamma m^2c^3}{\hbar}}{1 + 2i\left(\frac{mc}{\hbar}\right)x - 2\left(\frac{mc}{\hbar}\right)^2 x^2 - \frac{4i}{3}\left(\frac{mc}{\hbar}\right)^3 x^3 + O(x^4)}$$

But $f(x) = \frac{dE}{dx}$

$\therefore$

$$F(x) = \frac{dE}{dx} \approx \frac{\frac{4i\gamma m^2c^3}{\hbar}}{1 + 2i\left(\frac{mc}{\hbar}\right)x - 2\left(\frac{mc}{\hbar}\right)^2 x^2 - \frac{4i}{3}\left(\frac{mc}{\hbar}\right)^3 x^3}$$

Taking the imaginary of the denominator

$$F(x) = \frac{dE}{dx} \approx \frac{\frac{4i\gamma m^2 c^3}{\hbar}}{2i\left(\frac{mc}{\hbar}\right)x - \frac{4i}{3}(\frac{mc}{\hbar})^3 x^3}$$

We saw that,

$$\frac{dE}{dx} = \frac{\Omega \mathrm{i}}{4i\left(\frac{mc}{\hbar}\right)x} + \frac{\Gamma\Omega \mathrm{i}}{4i\left(\frac{mc}{\hbar}\right)x\left[\frac{1}{2} - \frac{2}{3}(\frac{mc}{\hbar})^2 x^2\right]}$$

$$\frac{dE}{dx} = \frac{\Omega \mathrm{i}}{4i\left(\frac{mc}{\hbar}\right)x} + \frac{\frac{\left[1 - (\frac{1}{2} - \frac{1}{3}(\frac{mc}{\hbar})^2 x^2\right]\Omega \mathrm{i}}{4i\left(\frac{mc}{\hbar}\right)x}}{\left[\frac{1}{2} - \frac{2}{3}(\frac{mc}{\hbar})^2 x^2\right]}$$

For $x^n \gg x^{n-2}$ $where\, n \in Even,\; n \geq 4$

$$F_1(x) = \frac{dE_1}{dx} \approx \frac{\frac{4i\gamma m^2 c^3}{\hbar}}{4i\left(\frac{mc}{\hbar}\right)x} = \frac{\gamma mc^2}{x}$$

$$\Pi_F = \frac{dE_2}{dx} \approx \frac{-3\hbar^2}{mx^3}$$

$$F(x) = \frac{dE}{dx} = \frac{\gamma mc^2}{x} \oplus \frac{-3\hbar^2}{2mx^3} \oplus \Gamma\, O(x) \ldots$$

But

$$F = G\frac{Mm}{x^2} = \frac{mc^2}{x} \qquad => \qquad x = \frac{Gm}{c^2}$$

We can extrapolate this to time and acceleration as

$$x = \frac{Gm}{c^2} \qquad t = \frac{Gm}{c^3} \qquad a = \frac{c^4}{Gm}$$

Or

$$R = \frac{2Gm}{c^2} \qquad T = \frac{2Gm}{c^3} \qquad A = \frac{c^4}{2Gm}$$

Using $x = \frac{Gm}{c^2}$ we can write

$$F(x) = \frac{dE}{dx} = G\frac{Mm}{x^2} \oplus \frac{-3c\hbar^2}{2GMmx^2} \oplus \Gamma\, O(x) \ldots \tag{16}$$

Where $\Pi_F = \frac{-3\hbar^2}{mx^3} = \frac{-3c\hbar^2}{2GMmx^3}$ is the quantum gravity force or the dark matter force

$$V(r) = \frac{GMm}{r} + \frac{L^2}{2r^2}$$

We saw that

$$V(r) = \frac{GMm}{r} \sum \Pi_i$$

∴ Total Potential is

$$V(r) = -\frac{GMm}{r} \sum_{i}^{\infty} \Pi_i + \frac{L^2}{2\mu r^2}$$

The first term will betray itself on cosmological scales while the last term will be apparent in microscopic scales

The Time-like Domain

$$\Psi(x,t) = \Psi_0 e^{\frac{-i}{\hbar}(px-Et)}$$

In the time domain,

$$E = \gamma mc^2 e^{-\frac{2i}{\hbar}(Et)}$$

$$\frac{dE}{dt} = \gamma mc^2 \left(-\frac{2i}{\hbar}\right)(mc^2)e^{-\frac{2i}{\hbar}(Et)}$$

Finding the Taylor Polynomials of the exponentials

$$\frac{dE}{dt} = \frac{\frac{2i\gamma m^2 c^4}{\hbar}}{1 + 2i\left(\frac{mc^2}{\hbar}\right)t - \frac{4(\frac{mc^2}{\hbar})^2}{2!}t^2 - \frac{8i(\frac{mc^2}{\hbar})^3}{3!}t^3 + \frac{16(\frac{mc^2}{\hbar})^4}{4!}t^4 + \cdots}$$

Taking the imaginary part of the quotient

$$\frac{dE}{dt} = \frac{\frac{2i\gamma m^2 c^4}{\hbar}}{2i\left(\frac{mc^2}{\hbar}\right)t - \frac{8i(\frac{mc^2}{\hbar})^3}{3!}t^3 + \cdots}$$

$$\frac{dE}{dt} = \frac{\frac{2i\gamma m^2 c^4}{\hbar}}{2i\left(\frac{mc^2}{\hbar}\right)t\left[1 - \frac{4(\frac{mc^2}{\hbar})^2}{3!}t^2\right]} + \Gamma O(t) \dots$$

For $t^n \gg t^{n-2}$ $where\ n \geq 3$

In very special cases we can write

$$P(t) = \frac{dE}{dt} \approx \frac{\gamma mc^2}{t} \oplus \frac{3\hbar^2}{2mc^2t^3} \oplus \Gamma\ O(t) \dots \tag{17}$$

$$\Pi_P = \frac{3\hbar^2}{2mc^2t^3} \qquad |1^{st}\ dark\ matter\ term$$

$$E(t) = \gamma mc^2 \oplus \frac{3\hbar^2}{2mc^2t^2} \oplus \Gamma\ O(t) \dots$$

$$\Pi_E = \frac{3\hbar^2}{2mc^2t^2} \qquad |1^{st}\ dark\ matter\ term$$

$$\therefore P(t) = P_0 + P_{QG} \qquad where\ P_{QG} - is\ the\ Quantum\ Gravity\ Power$$

Temperature in QGD

now

$$E(t) = \gamma mc^2 \oplus \frac{3\hbar^2}{2mc^2t^2} \oplus \Gamma\ O(t) \dots$$

And $E = \frac{3}{2}k_bT$

$$\frac{3}{2}k_bT_t = \gamma mc^2 \oplus \frac{3\hbar^2}{2mc^2t^2} \oplus \Gamma\ O(t) \dots$$

$$T_t = \frac{2\gamma mc^2}{3k_b} \oplus \frac{\hbar^2}{mk_bc^2t^2} \oplus \Gamma\ O_T(t) \dots$$

Similarly

$$T_x = \frac{2\gamma mc^2}{3k_b} \oplus \frac{-\hbar^2}{mk_bx^2} \oplus \Gamma\ O_x(t) \dots$$

Hence

$$T_x = \frac{2\gamma mc^2}{3k_b}$$

and

$$T_x = \frac{-\frac{\pi}{2}\hbar^2}{mk_b\, {}^1\!/_2\, \pi x^2} = -\frac{\pi\hbar^2}{2mk_b A}$$

∴

$$\Pi_{T(x)} = -\frac{\pi\hbar^2}{2mk_b A} \quad and \quad \Pi_{T(t)} = \frac{\hbar^2}{mk_b c^2 t^2} \tag{18}$$

We can also write, without much loss of generality.

$$T = \frac{-\hbar^2 c^4}{gk_B G x^2}$$

Quantum Gravitational Waves

Consider an object of mass (m) moving through space with speed (v), by virtue of its kinetic energy it will have a greater mass in motion than at rest and hence a higher gravitational wave/field around it, as such

- kinetic energy of gravitating objects causes an increase in gravity.
- This change in gravity due to speed, affects the flow of time $t = t_0\sqrt{1-\beta^2}$.
- The loss of kinetic energy by an object can be transformed into emitted quantum gravitational waves
- Quantum Gravitational Waves can be emitted by an object in order to conserve the total energy / momentum.
- At any point in space, they will have the form $\tau E = nh$

We can model this change in kinetic energy as

$$\Delta E = \gamma mc^2 - mc^2$$

Thus

$$E = mc^2(\gamma - 1)e^{-\frac{2i}{\hbar}(Px-Et)}$$

This becomes

$$E \approx \frac{(\gamma-1)\hbar^2}{2mx^2} \approx \frac{v^2\hbar^2}{4mc^2x^2}$$

If we let $x = ct \;\; and \;\; E = mc^2$ then

$$E^2t^2 = \vartheta\hbar^2$$

Which gives $\tau E = nh$ as it should be.

Quantization of time and space

Starting from our equation of quantum gravity

$$\lambda = \frac{hc}{\sqrt{E^2 - (mc^2)^2}} e^{2i\frac{mc}{\hbar}(x-ct)}$$

By considering the time-independent solution for the quantization of space with constraints that would apply for a body such as the earth i.e. non relativistic speeds

$$\lambda = \frac{h}{mc} e^{2i\frac{mc}{\hbar}x}$$

Finding the first Taylor polynomial

$$\lambda = \frac{h}{mc}\left(\frac{1}{1+\left(\frac{mc}{\hbar}\right)^2 x^2}\right) \approx \frac{h}{mc}\left(\frac{\hbar^2}{m^2c^2x^2}\right) = \frac{h^3}{4\pi m^3c^3x^2}$$

$$\therefore \frac{\lambda}{\lambda^3} = \frac{1}{4\pi^2}\frac{1}{x^2}$$

Where we have used the De Broglie relation $\lambda = \frac{h}{mc}$ to convert the mass into wavelength

$$x = \frac{1}{2\pi}\lambda = \sigma\lambda$$

This shows that $x_0 = \sigma x$ is the shortest measurable time on earth based laboratories

$$\zeta x = \sigma\lambda \quad \left| \begin{array}{c} \zeta x \textit{ is the quantum of distance} \\ \sigma \textit{ is a constant} \\ \lambda \textit{ is the wavelength in a certain } g \textit{ field} \end{array} \right. \tag{19}$$

This result is an unexpected one; the distance that we measure is constant multiples of σλ. So

$$D = \{\sigma\lambda, 2\sigma\lambda, 3\sigma\lambda \ldots\} \qquad where \quad |D \textit{ is the field of any measurable distance}$$

We see that our equation of quantum gravity, says that the distance that our rods measure is quantized into scalar multiples of σλ. This result, tells us how the concept of length in a gravitational field is not arbitrary, length can only be measured in discrete quantas of length

$$\zeta x = n\sigma\lambda \quad where\ n = 1,2,3 \ldots$$

Let's define$\eta = n\sigma \quad |where\ \ \eta \textit{ is the scalar invariant}, \eta \geq 1$

$$\tau = \frac{h}{\gamma mc^2} e^{2i\frac{mc}{\hbar}(x-ct)}$$

Taking the first polynomial

$$\tau = \frac{h}{\gamma mc^2} \frac{\hbar}{mc^2 t}$$

We use $m^{-2} = \frac{\tau^2 c^4}{h^2}$ and $\tau E = h$

$$\tau = \frac{h^2}{2\pi c^4 t} \frac{\tau^2 c^4}{h^2}$$

$$\tau^{-1} = \frac{1}{2\pi t}$$

$$t = \frac{1}{2\pi}\tau$$

$$t = \sigma\tau$$

$$\zeta t = \sigma\tau \qquad |Let \quad \zeta t \ denote \ the \ quanta \ of \ time \tag{20}$$

$$T = \{\sigma\tau, 2\sigma\tau, 3\sigma\tau \ldots\} \qquad where \qquad |T \ is \ the \ field \ of \ any \ measurable \ time$$

- Time and space cannot be measured at random; only discrete values can be measured.

Quantum times and distances

In this section we need an equation that relates the gravitational acceleration (g), with the other quantities such as energy and wavelength.

$$\lambda = \frac{h}{mc} e^{\frac{2i}{\hbar}(px-Et)}$$

$$\lambda = \frac{h}{mc}\left(\frac{8\pi^2 m^2 c^2 x^2}{h^2}\right) = \frac{8\pi^2 mcx^2}{h}$$

Let $g\lambda = \Lambda \quad where \ \Lambda \ is \ an \ arbitrary \ variable$ and $g = \frac{GM}{x^2}$

$$\Lambda = \frac{GM}{x^2}\left(\frac{8\pi^2 mcx^2}{h}\right) = \frac{8\pi^2 m^2 cG}{h}$$

Using $m = \frac{h}{c\lambda}$ we find

$$g\lambda^3 = \frac{8\pi^2 Gh}{c}$$

$$\therefore \quad \lambda = \sqrt[3]{\frac{8\pi^2 Gh}{gc}}$$

From the previous section we saw how the shortest measurable distance will be

$$\zeta x = \frac{1}{2\pi}\lambda = \sigma\lambda$$

$$\zeta x = \frac{1}{2\pi}\lambda = \sigma\sqrt[3]{\frac{8\pi^2 Gh}{gc}} = \frac{1}{2\pi}\sqrt[3]{\frac{8\pi^2(6.67\times10^{-11})(6.63\times10^{-34})}{(9.81)(299792458)}}$$

Similarly

$$\zeta t = \frac{1}{2\pi}\tau = \sigma\sqrt[3]{\frac{8\pi^2 Gh}{gc^4}} = \frac{1}{2\pi}\sqrt[3]{\frac{8\pi^2(6.67\times10^{-11})(6.63\times10^{-34})}{(9.81)(299792458)^4}}$$

- Any speed in a gravitational wave can be measured, however, the maximum speed will be that which the wave itself travels
- Time and distance cannot be measured at random
- But in discrete values of ζx and ζt

The Scalar Invariant:

Time in quantum gravity is a quantity that depends on gravity as it traverses in space and time.

$$\tau = \frac{h}{\gamma mc^2}e^{2i(\frac{mc}{\hbar}x - \frac{mc^2}{\hbar}t)}$$

The measured time depends on gravity, thus different observers will measure different quantities:

$$\Delta t = \eta\frac{h}{\gamma mc^2}e^{2i(\frac{mc}{\hbar}x - \frac{mc^2}{\hbar}t)} \quad |The\ equation\ of\ time \tag{21}$$

The quantity η is a dimensionless quantity, which unlike τ *and* t that depend on other parameters η is invariant..

$$\eta_t = \frac{\Delta t}{\tau} \quad \left| \begin{array}{c} \Delta t\ is\ the\ time\ measured\ by\ clocks\ in\ a\ g\ field \\ \tau\ is\ quantum\ time\ which\ is\ interchangeable\ with\ energy\ and\ g \\ \eta_t\ the\ scalar\ invariant\ is\ a\ dimensionless\ quantity \end{array} \right. \tag{22}$$

η_t measures the true 'how long' an event took place, unlike measured time, which is frame dependent.

$$\Delta t = \eta \frac{h}{\gamma mc^2} e^{2i(\frac{mc}{\hbar}x - \frac{mc^2}{\hbar}t)} \quad |The\ equation\ of\ time$$

Thought Experiment: *To make this more lucid, lets propose a thought experiment. Say you are conversing with a certain well informed extra-terrestrial life form about current affairs, somewhere along this intriguing conversation, you asked the Alien, call him Bob, how long is your day, mine is 24hr, so I know what time to call you tomorrow. Bob quickly replies that his day is 324ξ. A great misunderstanding would ensue. Any use of fundamental constants, is relative, without invoking manmade standards, as well as the probable scenario that they, have they have not yet discovered that constant. The invariant scalar solves this extra-terrestrial enigma by requiring Alien Bob to provide his quantum time as well (or simply his value of g, since they are interchangeable), Bob readily gives his value of g: τ = 0.002ξ. With this we could use equation of* $\eta_t = \frac{\Delta t}{\tau}$ *to determine the dimensionless scalar invariant, thereafter convert to hours.*

$$\Delta t = \tau \eta_t$$

observe this measure of time has no units and it is the same for all observers in the universe. If one is given to curio further and asks Bob, how tall he is, from our studies in QGD, we realize that length is not an intrinsic quantity but depends mainly on gravity, just like time with their symmetry summarized as;

$$\begin{array}{ll} \Delta t = \tau \eta_t & \Delta x = \lambda \eta_x \\ \tau E = h & \lambda p = h \\ \Delta t \Delta E = \hbar & \Delta x \Delta p = \hbar \end{array}$$

<u>All observers in physical space will agree on the value of the unitless invariant scalars of length, time and speed.</u>

$$\eta_v = \frac{\eta_x}{\eta_t} \quad \left| \begin{array}{ll} \eta_x & invariant\ length \\ \eta_t & invariant\ time \\ \eta_v & invariant\ speed \end{array} \right.$$

This will be the invariant speed.

Time Dilation and Contraction

We saw how two observers will always measure the same value for the invariant η. If we have two observers A and B in different frames measuring the same length x, then;

$$\Delta x_A = \lambda_A \eta_A \quad and \quad \Delta x_B = \lambda_B \eta_B$$

By definition of the invariant $\eta_A = \eta_B = \eta$, therefore;

$$\Delta x_A = \frac{\lambda_A}{\lambda_B} \Delta x_B \quad or \ \ \Delta x_0 = \frac{\lambda_0}{\lambda} \Delta x$$

If we recall that the

- Gravity becomes precisely defined when the uncertainty of the Shwarzchild radius (R_s) $\Delta R_s \Delta p \geq \frac{\hbar}{2}$ has a definite value, such that $R_s = \frac{2GM}{c^2}$

Then

$$\lambda_{Horizon} = \frac{h}{mc} e^{\frac{2i}{\hbar}(pR_s - Et)}$$

Will be the gravitational field at the Event Horizon, then

$$\mathrm{d}x' = \frac{\lambda'}{\lambda}\mathrm{d}x = \frac{\frac{h}{mc} e^{\frac{2i}{\hbar}(pR_s - Et)}}{\frac{h}{mc} e^{\frac{2i}{\hbar}(pr - Et)}} \simeq \frac{R_s}{r} dx$$

it's easy to show that

$$\mathrm{d}x' = \frac{(\lambda')^n}{(\lambda)^n}\mathrm{d}x \simeq \frac{R_s}{r} dx \qquad for\ all\ n \in \mathbb{R} \tag{24}$$

This is the length contraction due to gravity, similarly for time;

$$\Delta t_A = \frac{\tau_A}{\tau_B}\Delta t_B \quad or \ \ \mathrm{d}t_0 = \frac{r_s}{r}\mathrm{d}t$$

This will be the time dilation due to gravity. From relativity we already know that $\Delta t_0 = \sqrt{1-\beta^2}\Delta t$ and $\Delta x_0 = \sqrt{1-\beta^2}\Delta x$. Thus the full length and time contractions due to gravity and speed is;

$$\Delta t_0 = (\sqrt{1-\beta^2} + \frac{\tau_0}{\tau})\Delta t$$

$$\Delta x_0 = (\sqrt{1-\beta^2} + \frac{\lambda_0}{\lambda})\Delta x$$

The Space-Time Invariant:

If we now consider the quantity

$$S^2 = c^2 t^2 - (x^2 + y^2 + z^2)$$

Where m and t are quantum gravity numbers with metric

$$\eta_{\mu\nu} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix},$$

The last three terms represent the Clifford Space, the arena which all events occur while t is due to the energy of the particles in this arena such as gravity, and since time is gravity the combination of $\mathbb{R}^3$ and gravity form a composite space-time. Let's define

$$S^2 = {S_t}^2 + {S_x}^2$$

Where

$${S_t}^2 = c^2 \frac{r_s}{r} t^2 \quad and \quad {S_x}^2 = \frac{r_s}{r} x^2$$

If we consider a space time interval dS, between two points, we then have

$$dS^2 = d{S_t}^2 + d{S_x}^2 = c^2 dt^2 - c^2 \frac{r_s}{r} dt^2 + \frac{dr}{1 - \frac{r_s}{r}} + r^2 d\Omega$$

$$dS^2 = (1 - \frac{r_s}{r}) c^2 dt^2 + \frac{dr}{1 - \frac{r_s}{r}} + r^2 d\Omega$$

Since $r_s = \frac{2GM}{c^2}$, then

$$dS^2 = (1 - \frac{2GM}{c^2 r}) c^2 dt^2 + \frac{dr}{1 - \frac{2GM}{c^2 r}} + r^2 d\Omega \qquad (25)$$

Is the solution of a slowly moving mass, non-rotating, uncharged mass – The Shwarzchild Solution of General Realtivity[16] without the use of curved spaces.

As such we can write the total gravitational potential of Quantum Gravity Dynamics, as

$$V(r) = -\frac{GMm}{r} \sum \widehat{\Pi}_i + \frac{L^2}{2mr^2} + \frac{GML^2}{r^3} \qquad (26)$$

Whereby the last term, which is responsible for the light deflection and Mercury's precession and is solely due to the gravitational dilation [35].

We can also write the space-time invariant using quantum gravity dynamics

$$S^2 = c^2 (\frac{1}{2\pi} m\tau)^2 - \left((\frac{1}{2\pi} n\lambda)^2 + y^2 + z^2 \right)$$

The action can be written as

$$S = \frac{1}{2\pi}\int_{\mathbb{R}\,space} L_{QGD}\, d^3x = n\hbar \quad n > 1$$

Where

$$L_{QGD} = {}^{1}/_{2}\, m\dot{r}^2 - \frac{GMm}{r}\sum \widehat{\Pi}_i + \frac{L^2}{2mr^2} + \frac{GML^2}{r^3}$$

With

$$\frac{d}{dt}\frac{d}{d\dot{r}} L_{QGD} - \frac{d}{dr} L_{QGD} = 0$$

For motion of non-relativistic test particles

The Force in Quantum Gravity Dynamics

By using the relations $ct \to {}^{E}/_{c}$ and $x \to p_x$, Special Relativity, allows us to write,

$$E = \sqrt{1 - \frac{r_s}{r}}\, E'$$

therefore

$$E(x) = \frac{\gamma mc^2}{\sqrt{1 - \frac{r_s}{r}}} e^{-2i/_{\hbar}(Px)}$$

Or

$$E(x) = \Lambda \gamma mc^2 \cos {}^{2}/_{\hbar}\,(mcx), \qquad where\ \Lambda = \frac{1}{\sqrt{1 - \frac{r_s}{r}}}$$

$$F(x) = \frac{dE}{dx} = \frac{-2i\gamma m^2 c^3}{\hbar\sqrt{1 - \frac{r_s}{r}}} e^{-2i/_{\hbar}(mcx)}$$

∴

$$F(x) = \frac{dE}{dx} = \frac{-2i\gamma GM^2 mc}{r\hbar\sqrt{1 - \frac{r_s}{r}}} e^{-2i/_{\hbar}(mcx - mc^2 t)} \tag{27}$$

Or

$$F(x) = \frac{dE}{dx} = \frac{2i\gamma GM^2 mc}{r\hbar\sqrt{1-\frac{r_s}{r}}} i \sin {}^{2}/_{\hbar} \left(mcx - mc^2 t\right) \tag{28}$$

This is the Newtonian Universal Gravitation Force in Quantum Gravity Dynamics.

The dual gravity paradox:

In this text we have derived gravity from a quantum mechanics viewpoint, guided by the idea that gravity instead of curvature of space as first proposed by Einstein is a similar to the De Broglie wave. Let us make this distinction using a thought experiment.

Consider a civilization that dwells on a tiny macro-molecule "planet". Equipped with scientific knowledge, they measure the de Broglie wavelength of a single molecule (λ_i) *as well as the entire planet (cluster of molecules)* $\lambda = n\lambda_i$ *n being the number of molecules. The matter wave certainly has a force* $F = \frac{dE}{dx}$*. As the micro planet increases its size to an earth like planet in size* $\lambda = N\lambda_i$.

This Matter Wave; E=hf, can be written as $f = \frac{Nmc^2}{h} = \frac{Mc^2}{h}$ *with the energy being proportional to the mass of the earth. It would not take .*

klnhomuch insight for the dwellers to reach at similar equations to that of Newton by $F = \frac{dE}{dx} = \frac{\gamma mc^2}{x}$*.* *If an earth based scientist would visit this planet in hopes of convincing them that gravity is caused by an unknown mechanism as per Newton or a fictitious force caused by the warping of space as Einstein elaborated an obvious problematic scenario would ensue.*

Paradox: *How can gravity be due to two (unrelated) forces?*

1) *The warping of space as per Einstein*
2) *The Matter waves of quantum mechanics*

They are led to two competing theories

i. Gravity is caused by the warping of space-time.
   - If this is true. There must exist a yet unobserved force due to matter waves, $F_{gravity} = F_{curvature} + F_{matter\ waves}$, i.e. gravity should be at least twice as strong as it is now

ii. Gravity is caused by matter waves.
   - This resolves the paradox.
     Hence; $F_{gravity} = F_{curvature} = F_{matter\ waves}$

Chapter 4: Transmutation

All the fundamental waves of nature emerge from a humble beginning presented by this relation

$$Let \qquad \psi = \begin{bmatrix} {}^{2}_{0}\psi & color\ wave \\ {}^{1}_{1}\psi & electromagnetic\ wave \\ {}^{0}_{2}\psi & gravitational\ wave \end{bmatrix}$$

$${}^{i}_{j}\psi\,, \quad i + j = 2, \qquad where \quad \begin{vmatrix} i - upper\ rank \\ j - lower\ rank \end{vmatrix}$$

The rank *of a wave is the sum of the lower and upper rank of its wavefunction and it is always equals to two.*

We proposed the idea that gravity is a wave – the matter wave of quantum mechanics. A matter wave can take on any of the three forms as color, electromagnetic or gravitation i.e.

- A Matter Wave is given by the equation

  $$i\hbar \frac{\partial}{\partial t} {}^{i}_{j}\Psi = \mathrm{H}\, {}^{i}_{j}\Psi$$

  Where H, can be the Hamiltonian of Quantum Chromo-dynamics, Quantum Electrodynamics or Quantum Gravity-dynamics

- A matter wave can either increase/decrease (i.e. the gravity increasing/decreasing due to the addition of mass) or a complete change in form of the matter wave. For example when an electron and a proton (electromagnetic matter wave) combine to form an atom (a gravitational matter wave)

  $$i\hbar \frac{\partial}{\partial t} {}^{1}_{1}\Psi_{PROTON} + i\hbar \frac{\partial}{\partial t} {}^{1}_{1}\Psi_{ELECTRON} = i\hbar \frac{\partial}{\partial t} {}^{0}_{2}\Psi_{ATOM}$$

- Macroscopic physics is the sum of individual microscopic physics, thus, gravity does not originate strictly from mass but rather is produced by particles carrying an electromagnetic wave such as a proton and an electron combining into an electrically neutral particle or color charged particles forming a color neutral (a triplet) and an electrically neutral particle such as a neutron or atom (*outside the particle).*
- This change of a matter wave from one form to another is the **transmutation** of a matter wave
- the electromagnetism of a proton, is not created by the charge, but rather, the combination of the three quarks, which are in a colorless state, meaning when the gluon force becomes colorless (in a singlet state), it changes/transforms into electromagnetism (outside of the proton), but this is true if and only if, they have reached a colorless state

  $$i\hbar \frac{\partial}{\partial t} {}^{2}_{0}\Psi_{up} + i\hbar \frac{\partial}{\partial t} {}^{2}_{0}\Psi_{up} + i\hbar \frac{\partial}{\partial t} {}^{2}_{0}\Psi_{down} = i\hbar \frac{\partial}{\partial t} {}^{1}_{1}\Psi_{proton}$$
- The rank of a wave tells us about, its ability to transmute in either the forward direction or the reverse direction.

- When quacks combine, but do not form a (neutral) colorless state, the resulting wave is still color and not electromagnetism
- When charges combine but do not form a neutrally charged particle/object, that particle/object cannot be the source of gravity
- Hence a group of protons (size of the planet) can never gravitate.
- Gravitation is due to color neutral and electrically neutral particles.

Dark Energy:

If gravity indeed originates from protons and electrons (electrically charged particles) coalescing and combining to from neutral particles, there should be countless evidence supporting this idea at macroscopic scales

Thought experiment

1. *Consider a hypothetical spherical volume, with protons on one side and electrons on the other side. Separated from each other by an external force greater than their mutual attraction.*
2. *An experimenter located outside has no way of looking inside the sphere, and he would measure a purely electromagnetic wave ${}_{1}^{1}\psi_{electromagnetic}$ due to the non-interacting protons and electrons –there is no source of gravity.*
3. *We bring one electron and proton to the center of the sphere, to combine into a neutral atom ${}_{2}^{0}\psi_{gravity}$ (assuming our hypothesis is valid) gravity would be produced at the center of this sphere (although extremely tiny) – the atom being neutral will be a source of gravity*
4. *objects subjected to this sphere would start experiencing the force of gravity (in addition to the electromagnetic force)... with the strength of this induced gravity depending on the number of atoms (n) that bind at the center of the sphere.*
5. *Dark energy is simply the additional gravity that is created when charged particles become neutral*
6. *Electromagnetic energy transforms into gravitational energy*

$$\Phi_\lambda = \frac{hc}{\sqrt{(\delta E)^2 - ((\delta m)c^2)^2}} e^{2i\frac{(\delta m)c}{\hbar}(x-ct)} \qquad |\Phi_\lambda \; is\ the\ dark\ energy\ wavelength \tag{29}$$

Evidence #1: Planets

Now, instead of a hypothetical surface, let's subject this same reasoning to the Earth, which is a perfect experimental device to test our hypothesis. The core of the earth has free protons and electrons, that cannot bind into atoms, due to the high temperatures [Dynamo Theory, Geo-science[23]. There is a critical temperature (T_c) such that, if the temperature becomes less than T_c , i.e. $T < T_c$ atoms will start to form and hence gravity will increase. This increase in gravity should be evident in planets such as the earth.

Evidence #2: galactic center

In cosmological scales, this fictitious gravity presents itself as dark energy. The Galactic center (which has extremely high temperatures) [27] is cooling down, and as such the induced gravity (due to electrons and protons coalescing into gravity) causes a form of unexplained increase in gravity which we have diligently named Dark Energy.

Evidence #3: The inflation force

The yet unknown mechanism that was responsible for the inflation force in the later stage of the Big Bang was when plasma formed into atoms when the temperature was cool enough in the early universe.

This extra mass δm will be added as

$$V(r) = \frac{G(M+\delta m)}{r} \qquad Newtonian/Einstein\ Regime$$

$$V(r) = \frac{G(M+\delta m)}{r} + \frac{2^4}{4!}\frac{G(M+\delta m)}{r} = 1.67\frac{G(M+\delta m)}{r} \quad first\ Einstein\ correction\ \delta^1(N)$$

$$V(r) = 2.11\frac{G(M+\delta m)}{r} \quad second\ Einstein\ Correction\ \delta^2(N)$$

$$\vdots$$

$$\mathrm{V(r)} = \Omega\ \frac{G(M+\delta m)}{r} \quad The\ last\ Einstein\ correction\ \ \Omega = 1 + \frac{2^4}{4!} + \sum_{n=6}^{N}(\frac{4}{n^2+3n+2})$$

$$\frac{G(M+\delta m)}{r}\sum \widehat{\Pi}_i$$

$$F(x) = \frac{dE}{dx} = \frac{-2i\gamma G(M+\delta m)^2 mc}{r\hbar\sqrt{1-\frac{r_s}{r}}} e^{-2i/_{\hbar}((M+\delta m)cx-(M+\delta m)c^2 t)}$$

or

$$V(r) = -\frac{G(M+\delta m)m}{r}\sum \widehat{\Pi}_i + \frac{L^2}{2mr^2} + \frac{G(M+\delta m)L^2}{r^3} \tag{30}$$

Laws of Universal Origins:

1. Definition of the Hamiltonian (H) and the Lagrangian (L).

$$H = total\ energy\ of\ particle(s) + total\ external\ energy\ on\ particle(s)$$
$$H = E + \varepsilon = \sum E_i + \sum \varepsilon_i$$

$$L = total\ energy\ of\ particle(s) - total\ external\ energy\ on\ particle(s)$$
$$H = E - \varepsilon = \sum E_i - \sum \varepsilon_i$$

N.B! while H is suitable for describing the configuration of a wavefunction

$$i\hbar\frac{\partial}{\partial t}{}_j^i\Psi = \mathrm{H}_j^i\Psi$$

The Lagrangian L is more suitable for the trajectories and interaction of the particle(s)

2. a)

$$\varXi = \mathbb{R}^3 + \mathbb{O} \qquad where\begin{cases} \varXi - Everything \\ \mathbb{R}^3 - Euclidean\ Space \\ \mathbb{O} - Nothing \end{cases}$$

b) The total energy of a particle or an ensemble of particles E, is ***exactly equal*** but opposite in magnitude to its encompassing matter wave

$$i\hbar\frac{\partial}{\partial t}{}_j^i\Psi - \mathrm{H}_j^i\Psi = 0$$

c) The solution of this equality is

$$\Psi(x,t) = \Psi_0 e^{\frac{-i}{\hbar}(px-Et)}$$

This describes how the wave evolves in space and time

3. a)

$$\begin{array}{ccc} Few\ particles\ (QFT) & & Many\ particles\ (QGD) \\ \Delta x(\Delta\psi)^2 = \Delta x\psi^*\psi \geq \varepsilon & \rightarrow & \psi^2 = \frac{\varepsilon}{\lambda} \\ \Delta p\Delta x \geq \frac{h}{4\pi} & \rightarrow & \lambda p = h \\ \Delta E\Delta t \geq \frac{h}{4\pi} & \rightarrow & \tau E = h \\ \vdots & & \vdots \\ \vdots & & \vdots \\ \int_{all\ space}\psi^*\psi dx = 1 & \rightarrow & \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q_\alpha}}\right) - \frac{\partial L}{\partial q_\alpha} \\ A = \int D(all\ paths)e^{\frac{i}{\hbar}(\int L(x,\dot{x})dt} & \rightarrow & E = E_0 e^{-\frac{2i}{\hbar}(p^\mu x_\mu - Et)} \end{array}$$

4. Matter waves can transmute when neutrality is reached

$$i\hbar\frac{\partial}{\partial t}{}_1^1\Psi_{PROTON} + i\hbar\frac{\partial}{\partial t}{}_1^1\Psi_{ELECTRON} = i\hbar\frac{\partial}{\partial t}{}_2^0\Psi_{ATOM}$$

5. The action (I) represents the physically acceptable configurations

$$I = nh \quad n \geq 1 \quad i.e\ \ I \geq h$$

$$if\ I = h \quad then \quad \psi = \psi_0\ ,\ thus\ e^{\pi i} = 1$$

6. The entropy of an ensemble of particles

$$\infty > S > 0$$

7. ***Principle of Universal Equilibrium:*** Every system or subset of that system has an intrinsic tendency to retain its equilibrium state with any variation of energy so as to conserve its initial properties.
   - An electron emitting / absorbing a photon and moving to a lower / higher orbit
   - A compressed or stretched string trying to return to its original state (Hooke's Law)
   - Newton's first and third law (Mechanics)

- Lenz's Law (electromagnetism)
- Fermat's principle (optics)
- Variational Principle (classical mechanics) $\delta H = 0$
- Gravitational waves

Conclusion: implied by the the equations is the idea that gravity waves can be generated in the laboratory not only from gravitational sources but also from electromagnetic sources.

It is necessary to admit that I have not attempted to answer the question of where does the three dimensional space come from or how it came into being… but we have showed how from a rudimentary but supremely powerful idea such as the De Broglie wavelength, a theory of Quantum Gravity could be constructed, that quantizes time and distance, having the explanatory power of explaining the dark energy and the dark matter problem. I will quote Albert Einstein in a letter to Besso in 1954[28] [I consider it quite possible that physics cannot be based on the field concept (differential geometry), i.e. continuous structures. In that case, nothing remains of my entire castle in the air, my gravitational theory included], It is with a heavy heart that we must abandon, our geometric space-time view of gravity in favor of the Quantum Mechanics view (discrete structures) of space and time -- a wave view of gravity -- as we once did the instantaneous force... one sees that there is economy in this way of thinking, and this change, is not only consequential... but inevitable.

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