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H particle-paths hypothesis
(A new thought in theoretical physics)

Volume two

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Part 3d- Force carrier particles

5(16) – Wave-like structure of gravitational field

5(16)1-General aspect

5(16)1a-Preliminary step

A) Introduction

Considering, *Sec. 5(7)1,* supposing sphere related to Schwarzschild radius, l_s , *Eq. 5(31),* of a mass *M* as its gravitational ground sphere; thus, the wavelength of H particle-paths on this surface is equal to Planck length, l_p, *Eq. 5(33).* Now, according to this assumption the wavelength of the gravitational field related to a sphere at the radius, $r>l_s$, *Comment 5(16)1a1*, from the center of gravity of the mass M is as following:

$$\lambda_r = \frac{l_p}{l_s}\times r = \frac{r}{M}\sqrt{\frac{c\hbar}{G}} = \frac{2\pi r}{cM}\left(\frac{a_s}{b}\right) \quad \text{; please refer to } \textit{Eq. 5(49)} \qquad \text{or} \qquad 5(46)$$

$$\lambda_r = \frac{M_P r}{M} \qquad 5(47)$$

Where:

- $a_s = 1s^{-1}$, *Note 1(2)1,* $b = 1kg^{-1}, u = 1m^{-1}$ of inverse dimensions based on units of dimensions in *SI* units.
- M_P – Planck mass *Eq. 5(34)1*.

Thus, λ_r is the wavelength of the stationary wave, *Sec. 2(4)4b*, with the reversible H particle- paths, at counter-currency mode, *Sec. 3(1)2,* that is proportional to r/M on gravitational sphere of radius r. According to counter-currency mode of posipa and negapa motions, this wave may have one of the configurations at the cases of the mass *M* at rest, *Figs. 3(4), a, b*, or at motion, *Fig. 3(5)a, b;* respect to an observer at rest in the related reference frame. Thus, to each point of the gravitational field texture of the mass *M*, besides its three-dimensional coordinates is related a wavelength λ_r that correspond to it a time coordinate t (or time interval ΔT) according to the H particle-paths bending characteristics, *Sec. 2(1), Fig. 2(3).*

Now, assuming an object of mass m, as in *Sec. 5(11)* falling in the gravitational field of mass *M,* (*M*>>*m*), e.g. an elementary particle initially at rest at point *P* far enough from mass *M* related to it a nil gravitation of mass *M*. Supposing, the relative distance of gravitational center of the masses m& *M* is equal to r, i.e. the gravitational sphere radius, r, of the field of the mass *M*. In addition, H particle–paths generation rate as gravitational spheres of the field *M* is based on the Hubble constant, *Eqs. 5(7), 5(53).*

As mass m falling toward mass *M* its radial velocity, v_r increases; moreover, according to *Eq. 2(77):*

$$\lambda_\alpha = \frac{h}{p_\alpha} = \frac{h}{m\alpha c} \qquad 5(48)$$

Where; λ_α, α are the matter wavelength, and ratio of the number of single direction H particle-paths to that of reversible ones of mass m, *Eq. 2(7),* respectively.

In the *Eq. 5(48),* α is independent of the falling object mass .Moreover λ_α is proportional inversely to the magnitude of the mass m. By considering, *Sec. 5(11),* the falling of a particle m, e.g. electron, toward the center of mass *M* is similar to that of photon, *Fig. 5(7).*

Now, supposing each gravitational expanding sphere is born on the surface of sphere with Schwarzschild radius (ground sphere); thus, the time interval $d\tau$, *Remark 15(16)1a1*, between two successive births calculates as following:

According to *Eqs. 5 (7), 5(35)*, we have:

$$dM/M = R_n^{-1} = \frac{8\pi^2 G}{c^3}\left(\frac{a_s}{b}\right) = 1.95\times10^{-34} = 2A\hbar\left(\frac{bu^2}{a_s}\right) = 2A\hbar(S_u^{-1}) = 2A\left\|\hbar\right\| \qquad 5(49)$$

$2\hbar R_n$ = total angular momentum 5(49)1

Please refer also to *Note 3(1)1c, Eq. 2(17),* and *Note 3(1)2a, Eq. 3(27).*

In other words, any n_s (or n_G) group of H particle-paths in a gravitational sphere regardless of the n_s (or n_G) magnitude has an angular momentum $2\hbar$ individually. Moreover, due to additive characteristic of angular momentum of gravitational spheres, the latter are correlated as a unique H system, *Sec. 5(7)7.*

Please refer to *Sec. 5(7)1, Eqs 5(21) a, b*, *Remark 5(16)1a3*.

Now, supposing mass *M* is enclosed by an arbitrary volume *V*, therefore:

$$d\,\rho_u = \frac{d\rho}{\rho} = \frac{dM/V}{M/V} = R_n^{-1} \qquad 5(49)2$$

Where:

- $\rho, d\rho$ are mass density and its variation; thus, $d\,\rho_u$ is the unit of mass variation (or loss), please refer also to *Sec. 5(17).*

- S_u, action unit, i.e. $S_u = 1b^{-1}u^{-2}a_s$; please refer also to *Sec. 2(4).*

- *A*, Correction factor, *A= 0.9262*; please refer to *Sec. 5(16)1c, part A1.*

Considering:

$$\frac{dM/d\tau}{M} = H_o \text{ , Note 5(16)1a1} \qquad 5(50)$$

Thus, according to *Eqs. 5(49), 5(50)*, and referring to *Consequence 2(10)1c*, *Eq. 2(116)2*, we have:

$$d\tau = \left(H_o R_n\right)^{-1} = a_1^{-1} K_{m(f)} = \frac{8\pi^2 G}{H_o c^3}\left(\frac{a_s}{b}\right) = 0.85\times10^{-16}\,s \quad \textit{Remark 5(16)1a2,} \qquad 5(51)$$

Please refer also to *Note 7(4)1a* in this regards.

Where:

- *dM*, is mass diminution per unit of mass during formal time's arrow interval $d\tau$, or, in other words, mass equivalent to any gravitational sphere of mass-body *M*.

- a_1, constant of media coefficient, *Note 1(2)1*.

- $\|\hbar\|$, is dimensionless numerical magnitudes of h-*bar* of Planck constant h, *Remark 5(16)1a3*.

- $K_{m(f)}$, a formal proportionality constant that is equal to $\frac{K_m}{M}$. Where, K_m *Sec. 2(10)1, Eq. 2(117),* is a proportionality coefficient*;* please refer also to *Sec. 5(16)1c, part A1, Eq. 5(67)6.*

In fact in *Eq. 5(49),* the three units, b, u, a, are representation of Energy-Space-Time correlation; please refer to *Sec. 7(6).*

As a result, the Hubble constant, which is applicable in the stellar scale, may be extended in the quantization of microscopic object gravity.

According to *Note 2(3)1a, Eq. 2(56)*, we have:

$$\frac{dM}{M} = \frac{\upsilon_0}{n_0} = K_\Gamma \qquad 5(51)1$$

Where:

- υ_0, the frequency of stationary matterwave surrounding the mass *M*

- n_0, the frequency equivalent number of H particle-paths through mass *M*

Therefore, according to *Eq. 5(49)*, we have:

$$\frac{dM}{M} = R_n^{-1} = K_\Gamma = \frac{8\pi^2 G}{c^3}\left(\frac{a_s}{b}\right) = 1.95\times10^{-34} \qquad 5(52)$$

Thus, according to *Eqs. 5(51), 5(52),* we have:

$$d_\tau = \frac{K_\Gamma}{H_0} = \frac{K_{m(f)}}{a_1} \qquad 5(52)1$$

On the other hand, we have:

$$\Delta n = d_\tau^{-1} = H_0 R_n = \frac{H_0}{K_\Gamma} \qquad 5(53)$$

Where, the constant Δn can be regarded as frequency of gravitational spheres generation per mass unit, or, better to say, formal frequency of gravitational sphere generation. In fact, according to *Sec. 7(4)2f, Eq. 7(26),* ΔT_{0d} the time interval between two successive gravitational spheres depends inversely on the mass magnitude of related mass-body.

Resuming the stated above discussions, a gravitational field around a rest mass can be considered as concentric expanding spheres with a formal frequency of gravitational spheres generation, Δn, i.e. radially wave–like nature, on the basis of single direction H particle-paths motions, *Sec. 7(4)4*; whereas, the surface of each sphere has a tangentially wave-like texture. The both are based on counter-currency mode of motions of reversible H particle-paths. To have a rough idea on this kind of the wave pattern refer to *Figs. 5(8), 9(1);* please refer also to *Sec. 5(16)5.*

The total path L_t, related to N_0 H particle-paths confined in an H hall package of path-limit Γ_{mass}, *Note 5(16)1a2,* of a rest mass assuming their entire are in its individually no wave-like form inner the event zone of gravitational field. Thus, regarding an H particle-path as an individual H system with its own path-limit Γ_{mass}, *Sec. 5(16)1e*, we have:

$$L_t = N_0 \Gamma_{mass} = N_0 \frac{c}{a_{mass}} = n_s \frac{c}{a_{G1}}, \quad \textit{Comment 5(16)1a1} \qquad 5(54)$$

Thus, the path L_G related to an H particle-path of group of n_s (or n_G interacting, *Eq. 5(1)1*) ones (during exiting of a gravitational sphere) in the gravitational field of an expanding sphere at radius r location, is obtained as follow according to path-constancy, *Eq. 2(26),* and related path equality, *Note 2(1)4a,* of interacting H systems; thus:

$$L_t = L_G \cdot n_s = L_G . k_G n_G = N_0 \frac{c}{a_{mass}}, \textit{ Sec. 5(1), Remark 5(16)1a4} \quad \text{or}$$

Therefore, according to *Comment 5(16)1a2* we have:

$$L_G = \frac{L_t}{n_s} = \frac{L_t}{k_G n_G} = \frac{N_0}{n_G} \times \Gamma = \frac{N_0}{k_G n_G} \times \frac{c}{a}$$

Where, a the media coefficient, *Note 1(2)1.* Thus, according to *Sec. 5(7)1, Eq. 5(35),* we have:

$$L_G = \frac{N_0}{k_G n_G} \times \frac{c}{a_{mass}} = \frac{c}{a_{mass}} R_n = \frac{c^4}{8\pi^2 G a_{mass}} \left(\frac{b}{a_s} \right) =$$

$$\frac{c}{2A\hbar a_{mass}} \left(\frac{a_s}{b u^2} \right) = \frac{c S_u}{2A\hbar a_{mass}} = constant \textit{ , Note 5(16)1a2, Remark 5(16)1a4} \qquad 5(55)$$

Where:

n_s, are number of H particle-paths of a gravitational expanding sphere (Expandon, *Sec. 5(16)1c, partA3*)

a_{mass}, a_G, are the media coefficient, *Note 1(2)1*, in mass, and gravitational field media respectively, *Sec. 7(4)3*, *parts B, D*

N_0, total number of H particle-paths of related mass-body.

A, correction factor, *A= 0.9262*; please refer to *Sec. 5(16)1c, part A1*.

The path-limit Γ_G is a degree of curvature r_G^{-1} of the path L_G contracted as a curved segment as in, *Fig. 5(8).* This segment is extended (or unwrapped) according to gravitational sphere radius expansion up to rectilinear $\Gamma_G \to L_G$ path-limit; thus according to the above statement, the extent of wrapping of curvature r_G^{-1}, related to microstructure, *Sec. 5(4), state I* is obtained as following:

$$r_G^{-1} \propto L_G^{-1} = \frac{8\pi^2 G a_{mass}}{c^4} \left(\frac{a_s}{b} \right) = \frac{8\pi^2 G}{c^3 \Gamma_{mass}} \left(\frac{a_s}{b} \right), \textit{ Remark 5(16)1a5} \qquad 5(55)1$$

Please refer to *Sec. 5(16)3g*, *Remarks 5(16)1a5, a6*

In fact, according to *Eq. 5(55)1*, the macro-structure state, i.e. related to gravitational surface or sphere at curvature, r^{-1} *Sec. 5(4)2, state II* is defined by the sum of that of micro-structure, *Sec. 5(4)2, state I*, i.e. related to ellipsoid at curvature r_G^{-1}. In other words, each gravitational sphere at r radius contains, n_G local ellipsoids or spindles shape (i.e. micro-curved path-length), on its surface; on the other hand, the path-length related to each ellipsoid or spindle is equal to L_G, *Sec. 5(16)1e,* on this surface, *Example 5(16)1a1*. Moreover, the curvature of the L_G path is determined by r_G^{-1} in different point of the field, i.e. gravitational sphere r.

Consequence 5(16)1a1- As a result, the interaction between single direction negapa (type *R*), and posipa (type *L*) of the electron take place with that of reversible H particle-paths of the field, *Sec. 6(2)3*. It is accompanied by the H particle–paths displacement, *Figs. 9(2), 10(1)*, between the particle and the field based on Newton third law, *Sec. 5(2), Fig. 5(1).* In case of striking photon, the reversible H particle-paths of the mass *M* gravitational field (expanded form of the mass) as expanding spheres acts like a mass (contracted form of the field), *Note 2(1)3b*. It is along with increasing density toward the center of gravity of mass M according to *Mirror Image Effect, Sec. 6(2)3, (based on Newton third law*) in respect to photon interaction. By analogy, as a loose example, it can be compared by passing of the light through a gas or glass i.e. masses with reversible H particle-paths, at a decreasing speed, or better to say at c speed in non straight paths according to *Sec. 5(4)4*. Moreover, the Maxwell equations of the electromagnetic field in a matter media have the similar form as in a constant gravitational field. As an example one can simulates the light bending, *Sec. 5(10)1,* test in gravitational field to that of a transparent medium, the refractive index of which varies similar to the gravitational field intensity, i.e. $1/r$, *Sec. 5(16)2c.*

Note 5(16)1a1-According to *Eq. 5(50),* that is related to the exit of H particle-paths as expanding gravitational spheres, it is concluded that total expansion of the H particle-paths of the sphere, *Sec. 5(4),* in the Universe are proportional to the expansion of the latter. Thus, the expanding Universe is the result of H particle-paths of gravitational spheres expansion. Therefore, the more mass packed in a given region of space is accompanied by more space expansion at that region along with related time's arrow, *Sec. 5(16)7a*. In other words, high space-time curvature in respect to theory of general relativity accompanied by more force field–line *(CF), Sec. 5(3), Note 5(3)1a*, appearance in viewpoint of H particle-paths hypothesis. According to the definition of entropy, it increase as H particle-paths leaving its contracted form, *Sec. 11(1),* (mass) to its expanded one (field), or, quantum states

number increasing, *Example 15(16)1* .Thus according to the above statements, entropy of the Universe increases proportional to its expansions.

Note 5(16)1a2- according to *Sec. 7(2),* the common path-limit for a rest mass (contracted form of field) is equal to $1\times\Gamma_{mass}$ (or $\frac{c}{a_{mass}}$).

Comment 5(16)1a1- According to *Sec. 5(16)1c, A1*, any two successive gravitational spheres are separated by a time interval $d\tau$. Therefore, r_n the radius of the n^{th} gravitational sphere from the related center of mass is quantized accordingly. Factually, the λ_1, the wavelength of the standing waves on the first gravitational sphere, i.e. next to the Schwarzschild surface, can be regarded as stationary de Broglie matter wave, *Sec. 5(6)2*, of the rest mass. Noteworthy, according to *Sec. 5(16)1a, part B*, λ_1 is related to the main expandon. It split to sub-expandons, during its transfer to the next, i.e. number 2 gravitational sphere of main expandon wavelength λ_2 , and so on. As a result, the wave front of *CF1*-force lines, *Sec. 5(2)1*, is replaced by wave front *CF2*, and so on during gravitational sphere expansion that is not shown in *Fig. 5(8)* of *Sec. 5(16)1b, part A*, for the reason of simplicity. "The mass equivalency $m.c^2 = h.f$ applies to gravitational mass just as to inertial mass. From that, the gravitational mass has a corresponding equivalent frequency f ". "The applicability of using the frequency aspect of mass is the analysis of gravitation and the nature of the results obtained , would appear to imply a considerably grater significance for the frequency, that is the wave, aspect of mass, matter, and particles in general than has been heretofore recognized,"[498] *Abstract.* Please refer also to *Sec. 2(3)1, Sec. 5(7)6*, and *Sec. 5(6)1*.

Comment 5(16)1a2- According to *Sec. 7(4)3*, the media coefficient a is depended upon to the medium. In other words, the media coefficient a in a gravitational field is depends to the field strength (or potential) at a location. On one hand, by decreasing the field strength i.e. a decrement Γ is increased accordingly up to its magnitude in normal vacuum. On the other hand, during expansion Γ of an expandon, *Sec. 5(16)1c, part A3,* is split to two or more Γ units up to infinity by analogy to case of a particle, e.g. photon, *Comment 7(2)1a*. Please refer also to *Sec. 5(16)1b, part D*.

Remark 15(16)1a1- we denote hereafter τ as time's arrow, *Sec. 5(16)7a,* in order to distinguish it from symmetrical time *t*.

Remark 5(16)1a2 – Assuming:
- R_n , is the average of total number of gravitational spheres during compensation of an arbitrary mass *M* (or a fractional loss of mass-body *M*), *Sec. 5(8)1, Eq. 5(35).*
- $d\tau$, is the time interval between two successive gravitational spheres. Please refer to *Sec. 7(4)2e, item E*, concerning the emission time $d\tau$ (or ΔT) between two successive exits of gravitational spheres in case of a particle at quantum level.

Thus:
$H_o^{-1} = R_n.d\tau$, is the age of this compensation until present era that must be equal to the total age of the mass-body *M* (or Universe).
"The accelerating expansion of the Universe gives $H_o = 71 \pm 3.5 Km/Sec./Mpc = 2.3\times10^{-18} s^{-1}$, with this value for H_o the age H_o^{-1} is Gyr , whereas the actual age from the consistent model is $13.7 \pm 0.2 Gyr$." [277] *Critical observation.* Please refer also to *Sec. 5(1)1, Note 5(1)2.*

Remark 5(16)1a3 – The dimensionless numerical value of $2\|\hbar\|$ is equal to that of particle of spin-2; please refer to *Sec. 3(1)1, Note 3(1)1c, Comment 3(1)3,* and *Sec. 3(1)2, Note 3(1)2a, Eq. 3(27).* Noteworthy, the $\hbar$ value is obtained as following with 7.4% lower from its experimental value, thus:

$$\hbar = \frac{4\pi^2 G}{c^3}\left(\frac{a_s}{bu}\right)^2 = \frac{4\pi^2 G}{c^3} P_u^2 = 1.0552\times10^{-34}\ S_u \quad , \quad \text{and} \quad \|\hbar\| = 1.0552\times10^{-34} \qquad 5(55)2$$

Where, P_u , unit of linear momentum dimension.

P_u^2 , has always a positive value; therefore, this relationship is independent of right-and left-handed (or matter and antimatter) countercurrent Universes, *Sec. 5(16)9*; moreover, considering c as an immutable constant, $\hbar$ variation depends merely on probable *G* variation. Therefore, starting from Newton gravity and, considering the Hubble law and constancy speed of light, (path-constancy), on the basis of H particle-paths hypothesis one can obtain the equivalent value of Planck's constant of microcosm from macrocosm world.

Remark 5(16)1a4 –According to *Sec. 5(16)1c, part A-1, Eq. 5(67)6,* and applying $n_s = K_G n_G$, *Sec. 5(1)1, Eq. 5(1)1*, we have:

$$R_n^{-1}\frac{S_u}{2A\hbar} = \frac{K_m}{a_1}\frac{H_o S_u}{2A\hbar} \quad \text{or} \quad K_m = a_1 R_n^{-1} H_o^{-1} = 2A\hbar\, a_1 H_o^{-1} S_u^{-1} \qquad 5(55)3$$

$$L_G = \frac{c}{a_{mass}} R_n = \frac{c}{a_{mass}} H_o^{-1} . \; a_1 K_m^{-1} = \Gamma_{mass} H_o^{-1} a_1 K_m^{-1} \qquad 5(55)4$$

At the case of microcosm, e.g. particle, $K_m = 1$, *Sec. 2(10)1*. Please refer also to *Sec. 7(4)*.

$$L_G = \frac{c}{a_{mass}} a_1 H_0^{-1} = \Gamma_{mass} a_1 H_0^{-1} \qquad 5(55)5$$

Therefore, assuming H_o^{-1}, the age of the Universe, *Remark 5(16)1a2,* L_G will cover the whole Universe since the Big Bang, (analogous to a thread of a tissue) that constitutes the fabric of vacuum texture, *Sec. 5(16)3b*.

Remark 5(16)1a5 – According to *Eq. 5(49), 5(55,* and *Eq. 5(55)4:*

$$L_G^{-1} = \frac{a_{mass}}{a_1} \frac{H_o}{c} \cdot K_m = \frac{2A\hbar}{c} \cdot a_{mass} \left(\frac{1}{S_u} \right) = \frac{2A\hbar}{\Gamma_{mass}} \left(\frac{1}{S_u} \right) \qquad 5(55)6$$

Where:

- a_1, the constant of media coefficient, *Note 1(2)1*
- a_G, The media coefficient of gravitational field medium, *Note 1(2)1, Sec. 7(4)3, part B*
- Γ_G, path-limit through gravitational field medium
- $2\hbar$, angular momentum of an H particle-path (or a group of H particle-paths) at a closed path Γ_G each constituted of n_s cells (or n_G interacting cells) of radius r_c (or expandons, *Sec. 5(16)1c, part A3*) on related gravitational sphere of radius *r*; please refer to *Sec. 9(4), Eq. 9(43).* According to *Sec. 9(4),* considering the closed path of radius $r_c = r_G$ is equal to Γ_{G1} *Remark 5(16)1a6, Eq. 5(55)9,* and *Proposal 5(16)1a2*. Therefore, by analogy to *Note 3(1)2a, Eq. 3(27),* of an open-end path Γ, and considering, the wave-length $\lambda_{r1} = r_{G1}$ of gravitational field regarded as stationary de Broglie matter wave, *Sec. 2(4)4b*, related to ground expanding sphere can be obtained as following:

$$r_{G1} = \frac{\Gamma_{G1}}{\pi} = \frac{2\lambda_{r1}}{2\pi} = \frac{2h}{2\pi P_{G1}} = \frac{2\hbar}{P_{G1}}$$

Therefore:

$$M_{G1} = r_{G1} . P_{G1} = 2\hbar \qquad 5(55)7$$

M_{G1}, is angular momentum of a cell on ground sphere (main expandons), or, better to say, the path-length value of a close-ended expandon, *Sec. 2(4)4a*.

Where:

- P_{G1}, linear momentum of an individual cell (or expandon, *Sec. 5(16)1c, part A3*) of radius $r_c = r_{G1}$ related to path-limit Γ_{G1} of curvature r_G^{-1}, *Eq. 5(55)1*, on ground expanding sphere
- Γ_{G1}, the path-limit of a cell (or expandon) on ground sphere
- r_{G1}, the radius of curvature related to a cell of ground sphere

According to *Eq. 5(55)7* (that is based on path constancy, *Sec. 2(12)*) by increasing the mass, which is equivalent to increasing of n_s (or n_G), the p_r increases along with r_c diminution accordingly, or, in other words, the curvature r_G^{-1} increasing. Noteworthy, in *Eq. 5(55)1*, the space-time curvature r_G^{-1} is related to mass density, $\rho = 1$, *Eq. 5(49)1*, from viewpoint of *GRT* increases as ρ increases; moreover, its radius, r_G, must not confused with the radius r_c of each of the individual n_G cells, or with the radius *r* of gravitational sphere *r*. In other means, r_c is merely comparable with r_G from view point of H particle-paths hypothesis; please refer to *Sec. 5(16)1b, part A, Fig. 5(8), Example 5(16)1a2*. Noteworthy, in case of *Sec. 3(1)1,* the spin of free moving particle is $\hbar$; whereas, as stated in the above case, the spin to each of the gravitational spheres (or Expandon, *Sec. 5(16)1c, part A3*) is $2\hbar$.

Remark 5(16)1a6- According to *Sec. 2(4)1, Consequence 2(4)1, Sec. 2(4)4a*, and *Sec. 5(16)1e*, we have:

$$(\pi r_{G1})^{-1} = \Gamma_{G1}^{-1} \propto \|2\hbar\| \Gamma_{mass}^{-1} = K_\Gamma \Gamma_{mass}^{-1} = N_g . N_0^{-1} . \Gamma_{mass}^{-1} \text{, Sec. 2(4)4b} \qquad 5(55)9$$

Since, according to *Fig. 5(8),* $2\pi r_G = 2\Gamma_G$

Where, Γ_{G1} the path-limit of the ground sphere.

Proposal 5(16)1a1-According to *Sec. 5(16)1a, Eq. 5(49)1,* and referring to *Remark 5(16)1a5*, $2\hbar R_n$ is the total angular momentum of mass *M* gravitational field since Big-Bang, if the total R_n gravitational spheres are correlated, i.e. total expandons considered as a correlated unique H system, *Sec. 8(5)*. However, as in the *Sec. 5(16)5*, we encountered with a unique H system constituted of R_n correlated gravitational spheres (or expandons), i.e. a huge helical surface since the Big-Bang (R_n = 1) along

with a total path, $L_t = n\Gamma_G$, based on *Eq. 5(54)*. Please refer also to *Remark 5(16)1a4*. Therefore, just during a gravitational interaction, an expandon (or a group of that up to n_G ones on a gravitational sphere) of right-handed spin $2\hbar$, and type R_e path-length, *Sec. 5(16)11*, of h value is revealed. Similarly, according to Mirror Image Effect, *Sec. 6(2)3*, its related left-handedly contracting contracton conjugate, *Sec. 5(2)1c, part c* (or a group of that) of left-handed spin $2\hbar$, and type L_c path-length of h value, (i.e. at opposite sign of its type R_e one) is generated in the mass medium. Factually, any gravitational sphere of total path-length value $2\hbar$ is constituted of n_G cells (or expandons) each of stored path-length $2\hbar$, *Sec. 7(2), and Sec. 7(4)1, item 3.* The latter takes its existence just during a gravitational interaction, *Secs 7(4)2a, d*, along with contracton formation. Please refer also to *Sec. 5(9)3d, Fig. 5(5)2,* and *Sec. 5(16)5*.

Proposal 5(16)1a2- The path-limit on the Schwarzschild surface of radius l_s, $\Gamma_s = 2\pi l_s$ is elongated through the vacuum gravitating medium up to a gravitational interaction (or measurement, *Sec. 8(7)2*) accompanied by its conjugate through mass medium Γ_{mass} of equal magnitude path-length, but at opposite sign. By analogy to case of entangled pair of particle, *Sec. 8(9)1, Fig. 8(1),* the H hall package, *Sec. 5(16)3a,* of this path-limit takes its conventional value, Γ_G just during a gravitational interaction.

Example 5(16)1a1 – Considering each of expanding gravitational sphere with its n_s (or n_G) cells that is cut by reader page, by a loose analogy it can be compared with a ball-bearing in industry that is rolling at tangential speed v_t, *Sec. 5(16)1b, part A, paragraph 3*. Moreover, each ball can be compared by a far analogy with H particle-paths in a cell. Now imagine, this ball bearing is expanding at radial velocity v_r, *Sec. 5(16)1b, part A, paragraph 3*, in such a manner that the sum of v_t and v_r is constant, i.e. the total speed of individual H particle-path is equal to the light speed, *Sec. 5(16)1b, part A, paragraph 4*. Now imagine, another ball-bearing moving counterclockwisely as conjugate (or counterbalance) of the first one with the same shape, size and moving condition; please refer to *Sec. 5(16)1b, part A, paragraph 7; Secs 8(7), 8(9).* The above schema by a far analogy can be compared as reader page cut of an expanding gravitational sphere (or Expandon, *Sec. 5(16)1c, part A3)*. In a more general analogy, considering two spherical metal surfaces that sliding on each other through n_s metal balls. Now imagine, the full system is spirally expanding, *Sec. 5(16)5*, e.g. at spin $2\hbar$ in spatial medium, that is accompanying with its contracting conjugate; please refer to *Sec. 5(16)1a, Remark 5(16)1a5*. Therefore, according to *Sec. 1(3),* there is an external common motion of H particle-paths, i.e. sphere motion, and an individual internal motion of H particle-paths, i.e. ball motion.

Example 5(16)1a2 - Considering two mass-bodies m_2, m_1, e.g., $m_2 = 2\,m_1$, therefore $n_{G2} = 2\,n_{G1}$ and cell radii $r_{c2} = \frac{1}{2} c_1 r$, ($p_{r2} = 2\,p_{r1}$ for gravitational spheres $r_2 = r_1$ respectively; moreover $r_{G2}^{-1} = 2\,r_{G1}^{-1}$; where r_{G2}^{-1}, r_{G1}^{-1} are curvatures on the surfaces r_2, r_1 respectively. Please refer to *Sec. 3(1)1, Figs. 3(2), 3(3), paragraph IV,* in this regards that is related to an open path; therefore, it can be assumed for a closed path accordingly

Example 5(16)1a3 - As a simple example if a stone is dropped, it fall to the ground , the produced heat dQ, i.e. expanded form of H particle-paths as radiations, is the increment of heat energy at Kelvin temperature *T*, that is accompanied by increases of entropy, ΔS, *Sec. 11*; please refer to *Sec. 5(16)7a,* for additional information.

Example 5(16)1a4- As a result of general relativity in case of a central symmetric gravitational field as in, *Sec. 5(1),* the components of stress-energy tensor in Einstein equations obtained as:

$$T_\beta^\beta = P, \qquad T_0^0 = -E = -m\,c^2 \qquad and \qquad 5(56)1$$

$$R_\beta^\beta = \frac{4\pi G}{c^4} T_\beta^\beta = \frac{4\pi G}{c^4} P \quad , \quad R_0^0 = \frac{4\pi G}{c^4} T_0^0 = -\frac{4\pi G}{c^4} E \qquad 5(56)2$$

Where, *E, P*, are energy and impulsion (pressure) respectively and R_i^i, T_i^i are Ricci curvature and stress-energy tensor respectively. Moreover, *i* and β are 4 space-time and 3 spaces coordinates indices respectively.
According to *Eqs. 2(30), 6(2):*

$$P = m_0 \alpha c = N_0 . \alpha \frac{a_1 h}{c} = N_\alpha \frac{a_1 h}{c} \qquad 5(56)3$$

According to *Eqs. 5(55), 5(56)1* to *5(56)3*, we have:

$$R_\beta^\beta = \frac{P}{2\pi L_G} = \frac{N_\alpha}{2\pi L_G} \times \frac{a_1 h}{c} = \frac{a_1 N_0}{2\pi L_G} \times \alpha p \qquad 5(57)$$

$$R_0^0 = -\frac{a_1 N_0 h}{2\pi L_G} \qquad 5(58)$$

Where, in an arbitrary point of the field:

m_0 - The mass equivalent

N_α - The total number of single direction, or returned H particle-path *(M>m), Eq. 2(22).*

N_0 - The total number of initial H particle-paths of mass m

α - The ratio of returned H particle-path to that of initial one*, Eq. 2(7),* of mass m

p - Momentum related to an H particle-paths, i.e. $\frac{a_1 h}{c}$

- a_1 , constant of media coefficient, *Note 1(2)1.*

According to *Eqs. 5(55), 5(57), 5(58),* we have:

$$R_\beta^\beta = \frac{n_G \alpha p}{2\pi c} = \frac{n_{G\alpha}}{2\pi} \times \frac{p}{c} = \frac{n_{G\alpha}}{2\pi} \times \frac{a_1 h}{c^2} = \frac{n_{G\alpha}}{2\pi} \mu \qquad 5(59)$$

$$R_0^0 = -\frac{n_G}{2\pi} p = -\frac{n_G}{2\pi} \times \frac{a_1 h}{c} \qquad 5(60)$$

Where:

$n_{G\alpha}$ - The total number of H particle-paths force-line, *Sec. 5(2),* of gravitational sphere at radius r related to the field of mass *M* that is interacted with mass μ , i.e. $n_G \times \alpha$

μ - Mass equivalent of a H particle-path, i.e. $\frac{a_1 h}{c^2}$, *Eq. 2(32)*

Thus, R_β^β is the mass equivalent of interacted H particle-paths of the field of the mass *M* with that of mass μ by $1/2\pi$ factor and R_0^0 is moment variation of n_G H particle-paths of the gravitational sphere *r* by - $1/2\pi$ factor.

According to *Eq. 5(58)*:

$$E = 2\pi L_G R_0^0 \qquad 5(61)$$

Thus, energy is the product of the total moment variation of, n_G H particle-paths collection, moving at c speed, by the path-length $2\pi L_G$, i.e. work done by n_G H particle-paths in this path-length.

According to *Eq. 5(57):*

$$P = 2\pi L_G R_\beta^\beta \quad p = 2\pi L_G R_\beta^\beta \qquad 5(62)$$

Thus, the total momentum, *P*, is equals to the product of mass equivalent of interacted H particle-paths, moving at c speed, in a region along the path-length, $2\pi L_G$, during a time interval.

B) Expandons behavior through gravitational field

According to *Note 2(3)1a, Eq. 2(56),* and *Sec. 2(4)4a, the Eq. 5(55)g* can be written as following:

$\Gamma_{G1}^{-1} \propto K_\Gamma \Gamma_{mass}^{-1} = \upsilon_0 \cdot n_0^{-1} \Gamma_{mass}^{-1} = N_g \cdot N_0^{-1} \cdot \Gamma_{mass}^{-1}$ or

$$N_g \Gamma_{G1} \cdot K_m = N_0 \Gamma_{mass} \qquad 5(55)10$$

The *Eq. 5(55)10* is a result of path constancy, *Sec. 2(1)1*. Please refer also to *Note 5(16)3c1*.

Where:

- K_Γ , The proportionality factor of matter wave frequency υ_τ with that of n_τ frequency equivalent of related particle (or mass-body), please refer to *Sec. 7(4)2f* in this regards.

- N_{g1} , The total number of group of H particle-paths of a cell (or main expandon) of gravitational field of a mass-body m (or particle) related to frequency υ_0 of stationary matter wave, *Sec. 2(4)4b*, on the ground sphere.

- N_0 , The total number of H particle-paths of the mass-body m (or particle) related to frequency equivalent number n_0 .

- K_m , The proportionality as in *Sec. 2(10)1*, it is equal to n_s (or n_G interacting) cells in this case.

Noteworthy, in ground sphere, the path-length $N_{g1}\Gamma_{G1}$ is equal to the path L_G , *Eq. 5(55).* Moreover, the principal expandon *1* on ground sphere during its transition to expanding sphere *2* in a SN_r configuration, *Sec. 5(16)1b, part A*, is split to main expandon *2* (of total number of H particle-paths N_{g2} with path-limit Γ_{G2}) and sub-expandons *2* through the related cone-like cavity, *Sec. 5(2)1d, part D,*. Therefore, so on to subsequent gravitational spheres up to $n \to \infty$ in such a manner that the following relationship is holding:

$$N_{g1}\Gamma_{G1} = N_{g2}\Gamma_{G2} = N_{g3}\Gamma_{G3} = \ldots\ldots = N_{gn}\Gamma_{Gn} = L_G \qquad 5(55)11$$

Where, $n=1$ to n is the n^{th} gravitational sphere, *Note 5(16)1a, B1*. Therefore, through Γ_{Gn} increasing, the total number N_{gn} of H particle-paths in a cell (or main expandon) of n^{th} gravitational sphere is decreasing along with a_{G1}, *Sec. 5(16)1a, part c*, decreasing down to vacuum gravity free medium, *Comment 5(16)1a, B1*. Moreover, through any sub-expandon generation, the total H particle-paths of the main expandon, i.e. N_{gn}, is decreasing accordingly. While, its path-length remained unchanged, i.e. $2\hbar$, the same as sub-expandon; please refer to *Sec. 7(2)* in this regards. Factually, similar to Huygens Principle, *Comment 5(16)3b, B1*, in case of light propagation as wave through spatial medium, any n_s cell on gravitational sphere during its expansion acts as a new source of expandons generation. Factually, according to *Sec. 5(16)3b, Part B*, the trajectory of the main expandon as a particle in a n_s's cell obeys the main track, and sub-tracks in the gravitating vacuum texture medium at a probability manner, In other words, the expandons obeys mainly the main (or denser) track, *Sec. 7(4)3, part E1*. According to *Sec. 2(4)1*, N_{gn} is the population density of expandons in a spatial location on the n^{th} gravitational sphere e.g. a cell. Moreover, N_{gn}, *Eq. 5(55)11*, the total number of H particle-paths of main expandon in a cell (or H hall quantized package) confined in a path-limit Γ_{Gn}; thus, its path-length is extremum on the more probable track, i.e. main track. According to *Sec. 5(16)1b, part A, paragraphs 7, 21*, any expandon is confined in a superimposed H hall package, *Sec. 5(16)3a*, of right- and left-handed characteristic at slight preference of the former one at an indistinguishable manner, that reveals just during an gravitational interaction. Therefore, according to *Fig. 5(8),* on a gravitational sphere, the exit of an H hall package (or cell) in opposite direction, e.g. replacement with type *R*, radially from its cone-like cavity to the adjacent one. It is accompanied by the entrance of a reversed-handedness H hall package, i.e. type *L* one, (or vice versa) based on Mirror Image Effect, *Sec. 6(2)3*. Moreover, in any cone-like cavity, the transition of the main cell (or expandon) to the next upper state is along with its reversed-handedness. It is in accordance to *Sec. 7(4)2e*, according to that the transitions both tangentially, and radially of a main expandon have stay times ΔT_t, and ΔT_r respectively, *Remark 5(16)1b, A1*. As a result, the tangential velocity v_t, and radial one v_r, *Sec. 5(16)1b, part A, paragraph 3*, are non-continuous (or step-like). According to *Sec. 2(4)1*, and *Sec. 2(4)4b*, the tangential motion of a cell (or main expandon) has reversible characteristic along with reversible path-length in the same medium, e.g. vacuum. While, the radial motion of the cell to upper gravitational sphere (or level) has non-reversible characteristic accompanied by irreversible path-length of expanding type R_e one, through vacuum medium. It is along with contracting type L_c within mass medium due to contracton formation, *Sec. 5(9)3d, Fig. 5(5)2*, at equal magnitude, and opposite signs, *Sec. 5(16)11,* based on Mirror Image Effect, *Sec. 6(2)3*, i.e. two different media, *Sec. 7(4)3*. During transition, main expandon is accompanied by sub-expandons, i.e. spatial expansion, and time's arrow, *Sec. 5(16)7a*, due to main expandon, sub-expandons H hall packages generation, and contracton formation in mass medium; please refer also to *Comment 5(16)3b, D1*. Noteworthy, the stated above discussion is an example of reversible and irreversible path-lengths. In fact, before gravitational interaction (or measurement), the H particle-paths of the main expandon are correlated via its contracton conjugate to the related Planck area (or source) on the Schwarzschild radius of its mass-body via its contracton conjugate, *Sec. 5(2)1d, part D*, in its related common H hall package, *Comment 5(16)2a1*. Note that, the correlation of an expandon with related contracton is interrupted just during the interaction of expandon (or measurement, *Sec. 8(7)2*), e.g. with a particle, mass-body; please refer also to *Sec. 7(5)3b, item V*. The released contractons are transferred through H hall package tunnel to the supermassive black hole of host galaxies or clusters and irreversibly absorbed, *Sec. 5(7)8*.

Resuming, any gravitational expanding sphere of a mass-body is composed of n_s cells (or main expandons) each of N_g number of H particle-paths confined in an H hall package of path-limit Γ_g. Moreover, while n_s number has a constant value during a limited time interval, the total number N_g in a n_s's cell is decreasing during this time interval through sub-expandons generation each of path-length value $2\hbar$, the same as main expandon of the cell. It is along with spatial expansion, and time's arrow, i.e. H hall package increment.

Note 5(16)1a, B1- By analogy to wave front in case of Huygens's Principle, any gravitational expanding sphere constituting of n_s cells can be regarded as surface of n_s source of expandons generation. Therefore, the *CF*-lines cited in *Sec. 5(2)1, Fig. 5(1)*, can be regarded as intersections of gravitational spheres with the reader page. Similarly, the *CI*-lines, *Sec. 5(2)1a*, can be regarded as intersection of contracton flow front with the reader page. Please refer also to *Sec. 5(9)3d, Fig. 5(5)2*.

Comment 5(16)1a, B1- Similarly to n_s cells on a gravitational expanding surface in gravitating vacuum medium, any H hall package (or cell) of vacuum quantized texture in vacuum free gravitational field, generates expandons of path-length value $2\hbar$, and spin $2\hbar$. This kind of expandons generation is at equal probabilities and rates in all of the directions of the related spatial cell of the vacuum quantized texture. Factually, by analogy to H hall package (or cell) of vacuum gravitating medium, the H hall packages of gravity free vacuum also acts as a source of expandons formation that leading to H hall packages generation, i.e. self vacuum space expansion. Because of according to H hall package hypothesis, the normal vacuum medium is the ultimate expansion of primordial gravitational field medium remnant. Please refer also to *Sec. 7(4)3, parts A*, *B*

C) Particle red-shifting

According to *Sec. 7(4)3*, we have:

$$a_{G1}\Gamma_{G1} = a_{G2}\Gamma_{G2} = a_{G3}\Gamma_{G3} = \ldots\ldots\ldots = a_{Gn}\Gamma_{Gn} = c \qquad 5(55)11a$$

Therefore, according to *Eq. 5(55)11*, we have:

$$N_{g1}a_{G1}^{-1} = N_{g2}a_{G2}^{-1} = N_{g3}a_{G3}^{-1} = \ldots\ldots\ldots = N_{gn}a_{Gn}^{-1} = L_G \cdot c^{-1} \qquad 5(55)12$$

Considering $a_G^{-1} = \Delta T_G$, and referring to *Eq. 5(55)4* of *Sec. 5(16)1a*, we have:

$$N_{g1}\Delta T_{G1} = N_{g2}\Delta T_{G2} = N_{g3}\Delta T_{G3} = \ldots\ldots\ldots = N_{gn}\Delta T_{Gn} = L_G \cdot c^{-1} = R_n \cdot a_{mass}^{-1} = \left(a_{mass} \cdot H_0\right)^{-1} \cdot a_1 K_m^{-1} \qquad 5(55)13$$

Comparing the *Eq. 5(55)13* with the *Eq. 2(116)2* of *Consequence 2(10)1c*, the ratio $R_n \cdot a_{mass}^{-1}$ through spatial medium, there is a similarity with that of $K_m \cdot a_1^{-1}$ in mass medium. Factually, the path-length $N_{gn}\Delta T_{Gn}$ ($n = 1$ to n) in the *Eq. 5(55)13* of a cell as a unique H system, *Sec. 8(5)*, before interaction (or measurement, *Sec. 8(7)2*) can be written as: $\left[\left(N_{gn} + \sum \Delta N_{gn}\right) - \sum \Delta N_{gn}\right]\Delta T_{Gn}$. Where, $N_{gn}\Delta T_{Gn}$ is the path-length of the main expandon within a cell of n^{th} gravitational expanding sphere, the element $\sum \Delta N_{gn}\Delta T_{Gn}$ is the sum of sub-expandons of expanding type R_e path-lengths emitted by the cell during its transition to n^{th} gravitational expanding sphere. Thus, $-\sum \Delta N_{gn}\Delta T_{Gn}$, is the sum of equivalent contracting type L_c path-lengths of equal magnitude and opposite signs of related sub-contractons conjugates generation through mass medium, *Sec. 5(16)11*. In other words, according to path-constancy, *Sec. 2(1)2*, we have:

$$-\sum_1^n \Delta N_{gn}\Delta T_{Gn} = \left(\sum_1^n \Delta N_{0n}\right).\Delta T_{mass}$$

Where:

- ΔN_{0n} , the equivalent H particle-paths affected through the mass medium due to sub-contractons N_{0n} formation
- ΔT_{mass} , the time interval within the mass medium

According to *Eq. 5(55)13*, the stay time ΔT_{Gn} , *Sec. 7(4)2e*, is increasing by n increment. In other words, a particle, e.g. photon, confined in an H hall package of the n^{th} gravitational sphere has lower frequency respect to $(n-1)^{th}$ one, *Simulation 7(4)2e1*. Therefore, the particle is red-shifting during its recession from the gravitational field of a mass-body. Please refer also to *Sec. 5(11), Fig. 5(7), Sec. 7(4)2e, part B,* and *Note 7(4)2f, A2.* As a result, the stay time ΔT of a particle on a gravitational sphere specifying the clock rate in a location on the latter; *Note 5(10)1c*. Noteworthy, the Γ_{Gn} , and ΔT_{Gn} at its ultimate expansion reach the path-limit Γ_d , and stay time ΔT_d of gravitational field free vacuum medium, *Sec. 7(4)3, part A*.

5(16)1b- Gravitational field from viewpoint of H particle-paths hypothesis

A) Explanation of the figure 5(8)

1) A mass-body, *M*, at rest, *Comment 5(16)1b, A1,* and its related Schwarzschild radius, l_s *Eq. 5(31),* along with its gravitational field centrally symmetric is illustrated.

2) The gravitational field around mass *M* consists of n expanding spheres, *Sec. 5(4),* at radii r_n , *Comment 5(16)1a1*, as following:

I) The first of their coincide with the sphere of radius, l_s , i.e. Schwarzschild surface related to $n = 0$, *Consequences 5(16)1b,A1, A2*.

II) The other spheres *ES* have its own time, *t,* radius, wavelength, λ_r , *Eq. 5(46),* as illustrated in, *Fig. 5(8)*. Moreover, the cross section of H particle-paths fabric arrangement by reader page plane, i.e. xy , (or yz, xz planes) is illustrated in which the path constancy according to *Sec. 2(1)2*, is drawn for each *ES* sphere as in, *Fig. 5(8).*

III)

A) On the surface of each sphere *ES,* the clock time rate, *T*, is constant. However, according to *Eqs. 2(15); Figs. 2(3), 5(8*), the time interval of spheres *ES1, ES2, ES3*,…decrease radially, *Sec. 8(7)2, part G, item F,* on the basis of *Eq. 5(68)2, 3,* (*Consequence 5(16)1b, A3*) as follows:

$$T_1, T_2, T_3, \ldots. \quad [55] \qquad 5(63)$$

Thus, at the distinct distances from the mass *M*, there is a time slowness respect to the time at $r \to \infty$, i.e. time contraction; please refer to *Sec. 5(16)1a, part B*, *Sec. 5(16)1b, part F1*, and *Sec. 5(16)1c, Remark 5(16)1c1*, *Comment 7(4)2f, A1,* and *Sec. 8(7)2, part G, paragraph F.*

B) According to *Sec. 5(7)7*, the gravitational spheres *ES1, ES2, ES3*,… related to $n = 1, 2, 3, \ldots$.are correlated discrete levels. To each level appropriate an H hall quantized package, *Sec. 5(16)3a*, of path-length value h, *Sec. 5(16)3g*, just after a measurement (or interaction), *Sec. 8(7)2*. Factually, before interaction, the whole H system, (i.e. mass and its gravitational field) is regarded as a unique H system, *Sec. 8(5)*, of path-length value h.

C) In case of the rate of gravitational spheres generation, please refer to *Sec. 5(16)1a,* and *Sec. 7(4)2e, item E*, *Sec. 7(4)2f.*

3) According to the above statements:

A) The radial rate of expansion, v_r (with moving H particle-paths on sphere surface) decreases proportional to $1/r$, *Sec. 5(9)2*, till:

$$n \to \infty, \quad 1/r \to 0 \quad , \quad v_r \to 0 \qquad 5(64)$$

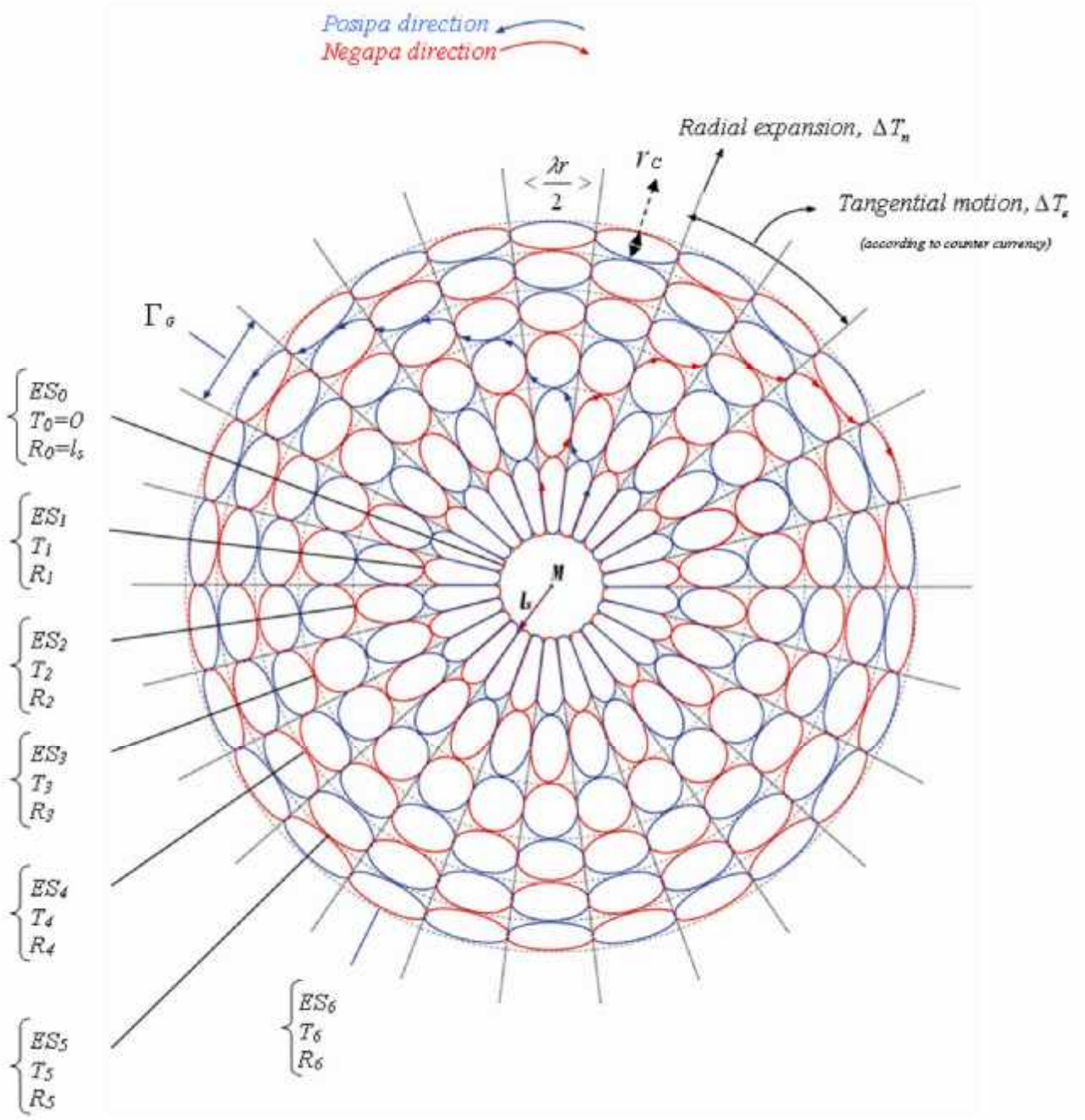
Moreover, the radial stay time interval, ΔT_r, *Eq. 2(97)1,* decreases accordingly, *Sec. 7(4)2f, part A*; it can be attributed to directional part of time arrow, *Sec. 2(1)1, Consequence 2(1)1b1, 3c, case II.*

B) The tangential speed, v_t of H particle-paths on each sphere *ES,* regarded as static (none expanding), i.e. posipa and negapa speed in the counter-currency mode of motion, *Sec. 3(1)2,* in the stationary wave state) increases proportional to $1/r$ as:

$$n \to \infty \,,\, 1/r \to 0 \;,\; v_t \to c \qquad 5(65)$$

Moreover, the tangential stay time interval, ΔT_t, *Eq. 2(97)1*, increases accordingly; it can be attributed to scalar part of time arrow, *Sec. 2(1)1, Consequence 2(1)1b1, paragraph 3c, case I.*

By analogy to discussion held on *Sec. 7(4)3, part E*, the both radial and tangential transfers of H particle-paths in an H hall package (or cell) of gravitational field are performed step-like at stay times ΔT_r, ΔT_t respectively. Therefore, the stay time $\Delta T_{r(g)}$, *Sec. 7(4)2f, part A,* can be regarded of non-steady expansion of a gravitational sphere time interval to an upper adjacent one.



ES= expanding sphere t *= time* r *= radius of expanding sphere*

$l_{s=}$ *Schwarzschild radius Eq.5(31)* $r_c = r_G$ *= radius of the cell (or expandon)*

ΔT_r *=time interval of radial expansion* ΔT_t *= time interval of tangential motion*

Fig. 5(8)-Diagram of reader page cross section of H particle-paths (posipa and negapa)

at counter-currency mode of motion in gravitational field of mass M (quantum gravity foam)
or gravity flower from viewpoint of *HPPH*

Noteworthy, the vacuum space quantized texture at this stage is related to its background space, *Sec. 5(16)3b*, its background time arrow, *Sec. 5(16)1c, part c*, respectively; moreover, its energy is related to vacuum background energy, *Sec. 5(16)3d*.
Please also refer to *Comment 5(16)1b, A2*, and *Sec. 5(16)1c, Remark 5(16)1c1*, and *Sec. 5(16)1a, part B*.

4) The total speed of H particle-paths on each expanding sphere *ES* is equal to c independent of radius r. In other words:

$$\vec{v}_r + \vec{v}_t = \vec{c} \quad \text{, Sec. 5(16)1c} \qquad 5(65)1$$

Thus, the sum of H particle-paths speed on each expanding sphere remains constant, i.e. c; moreover, only the shape of the H particle-paths alters as in, *Fig. 2(3)*.
5) According to above statements by considering *Fig. 5(8),* we conclude that the counter-current, *Sec. 3(1)2,* motion of H particle-paths at radial direction converts (or tends) to their motion at tangential direction during expansion (i.e. $r \to \infty$). As a comparison, the stretching of H particle-paths on expanding sphere can be compared by unwinding the coils of a compressed closed ring spring after releasing it that expand and continued to $1/r \neq 0$.
Referring to *Sec. 5(16)3a;* the H hall quantized packages contract or expand according to the population density of H particle-paths of the field (or curvature of expanding surfaces, $1/r$); therefore, the space geometry around mass *M* has a hard link with that. In other words, according to *paragraph 12* of this explanation, the space curvature is proportional to the degree of interaction (momentum, energy) of the field of mass *M* H particle-paths with that of a body of mass m. Please refer also to *Sec. 2(4), Sec. 2(4)1.*
6) The shape and mode of motion of internal H particle-paths of the mass *M* body is similar to that of its field except their radial motions of the former are reversible, *Note 5(16)1b, A3.*
7):
A) Each unit (or cell, *Remark 5(16)1b, A1*) of posipa-negapa in the *Fig. 5(8)* can be regarded according to *Eq. 2(15), Fig. 2(3), Sec. 2(1)1b, Delta Effect* as space-time texture at that location by analogy with the general relativity. Thus, the related time interval is obtained by dividing the paths of the units at related direction; moreover, the continuous space-time, *Comment 5(16)1b, Aa,* in classical general relativity is replaced by a discrete texture of lattice-like H particle-paths; i.e. posipa-negapa units , in accordance with the properties of quantum field theory[39]; please refer to *Sec. 5(16)3b, part A*. In other words, H particle-paths in its general paths during its motion bends according to space-time curvature as in general theory of relativity, *Sec. 2(4)1, Remark 2(4)1b*; but at a discrete or non continuous manner, i.e. discretized gravity; please refer to *Sec. 5(4)2*.
B) Considering the *paragraph A,* and referring to *Secs. 5(16)3, Sec. 5(16)3b,* and *Sec. 5(16)7a*, space along with time's arrow is generated by mass during gravitational closed surface expansion in the form of quantized units (Expandon, *Sec. 5(16)1c, part A3*) of negapa-posipa moving at c speed, *Fig. 5(8)*, *Remark 5(16)1b1*. Moreover, there is also an indistinguishably, *Note 5(16)1b, A4,* between negapa-posipa (type *R-L* of *SN* configuration, *Sec. 3(1)2, Fig. 3(4),* and *Comment 3(1)2b*) and posipa-negapa (type *L-R* of *SP* configuration) arrangements in each H hall quantized packages (or cell) at each instant along an arbitrary axis, *Remark 5(16)1b, A4.* Please refer to *Sec. 8(9)1*, and *paragraphs 15*, *21* of this section, and *Sec. 5(16)1c, Example 5(16)1a1*. According to [236]" Dr. John Wheeler proposed in *1960*'s that the quantum world could be described as swirling quantum foam, whereas space time is smooth (Peterson Loop)". Please refer also to *Note 5(15)2c1.*
C) Each gravitational sphere of *Fig. 5(8)* can be regarded by an analogy with a tissue, the fibers of it are the posipa and negapa of the cells that are woven as shown in *Fig. 5(8)* for gravitational sphere *No 1, 2, ...n;* please refer also *part D* of this section. These fibers of the tissue on each gravitational sphere according to its fabric (i.e. cell) define the related force-line *CF, Sec. 5(1)1*. Now, considering a mass m located in the external gravitational field of mass *M*, according to *Sec. 5(1)1, Fig. 5(2)* each force-line *CF* by the latter is accompanied by appropriate impulsion-line *CI* of the mass m to reach an equilibrium, *Remark 5(16)1b, A2*. Therefore, the force-line *CF* according to its fine structure (i.e. cells) designs the geodesic of mass *M* gravitational field, or, better to say the texture of bend vacuum space due to gravitational field of a mass-body, *Remark 5(16)1b, A3*. As a result, the action variation, δS, *Sec. 2(1)2, Eq. 2(103)2* is extremum along this geodesic (or fibers of the tissue) with minimum path-length variation.
D) During motion of mass m, its gravitational expanding spheres trace a track texture on the gravitational expanding spheres of the mass *M* (or vice versa) based on discussion held in *part 7(c)*.
E) During the motion, the SN_r and SP_l configurations of each cell are affected as following:
I) In a translational uniform motion of mass *M, Fig. 5(8),* along an straight line, the geometrical shape of negapa, and posipa of each cell are affected as in *Fig. 5(2)1a*, of *Sec. 5(2)2*.
II) Supposing mass *M* of *Fig. 5(8),* is rotating along its center of mass around an axis perpendicular to the reader page, the geometrical shape of negapa and posipa of each cell are affected as in *Fig. 5(2)1b*, of *Sec. 5(2)2*.
According to above statements, SN_r and SP_l are configurations of negapa and Posipa of the cells respect to an observer at rest, e.g., reader page. Please refer to *paragraph 15*, and *Sec. 5(2)1c*, in this regards.
8) The Schwarzschild surface is divided by Planck area units, *Eq. 5(37)2.* Moreover, the inner volume of event zone is separated ultimately by volume units, $V_{\min}$ *Eq. 5(37)2*, related to individual H particle-paths; thus, the maximum density at each of the units is $D_{\max}$ *, Eq. 5(37)4.*

9) It is preferred to consider the time interval as in *Sec. 2(1)1b, case3(c)*, and *Note 2(3)3b*, in which at radial direction of motion, we encounter with meaningless infinitely time dilation, *paragraph 2(c).* Whereas the related interval at tangential direction has a minimal finite time interval contraction, i.e. $\Delta T_t = \Delta T_p$, Planck time; thus, according to *Sec. 2(1), Eq. 2(15)*, and related proper length, $l' = l_p$ i.e. Planck length, *Eq. 5(37)*, we have:

$$\frac{l'}{\Delta T'} = \frac{l_p}{\Delta T_p} \quad , \quad \textit{Sec. 5(16)1c, part B,} \qquad 5(66)$$

that are consistent with the light trap conception and gravitational sphere expansion, *Sec. 5(4),* at the event zone respectively; therefore, by considering the latter, the energy lost by black hole is interpreted and can be compared by a far analogy with the Hawking's radiation [134], contrary to sophisticated pair production interpretation in that. Finally from the viewpoint of the object itself the time interval, ΔT_p *Eq. 5(66)*, can be regarded as the time that governs on the event zone. Regardless of the body radiation energy, there is an energy (or equivalent mass) loss by gravitational sphere, *Eq. 5(6),* that is in contradiction to the theory of general relativity. According to the space-time assumption in the latter, there is no energy loss in case of a mass as a symmetrical sphere at rest; please refer also to *paragraphs 3, 4.*

10) According to the wave-like nature of the gravitational field; the particle specially at low speed (e.g. cold neutron) do not move smoothly but jump from one height to another ,i.e. radially from a gravitational surface or state to other appropriate one [26].

11) To each H particle-path on the gravitational sphere of mass *M* is attributed a path-length proportional to L_G *Eq. 5(55);* thus, during interaction with an external H system (e.g. mass m) it acts as a force-line, *Sec. 5(2).*

12) According to *Sec. 5(1), Eq. 5(1), Fig. 5(1),* the flux of the H particle-paths through mass m in a time interval, ΔT, on the basis of *Eqs. 6(2), 6(3),* i.e. force, is proportional to $1/r^2$; since, the speed of H particle-paths are equal to c on each expanding gravitational surface, *Sec. 5(2)3, last paragraph, Fig. 5(5).*

13) According to the settlement of H particle-paths, i.e. posipa and negapa units on each gravitational sphere; there will be a correlation between the time and length, *Eq. 2(15),* in an individual H hall quantized package, *Sec. 5(16)3a,* just taking form during a gravitational interaction based on uncertainty principle, *Eqs. 7(5), 7(10);* moreover, H hall quantized packages stretched tangentially at tangential speed, *(v_t, paragraph 3B),* and compressed radially at radial speed, *(v_r, paragraph 3A),* in such a manner that *Eq. 5(70)4* of *Sec. 5(16)4* holds. In other words, the vacuum permeability related to the former increasing and the vacuum permittivity related to the latter decreases accordingly in each of the gravitational field locations. Noteworthy, the path-limit Γ_G of each of H hall package of ΔE energy and path-length value h, *Sec. 5(16)3g,* on Schwarzschild surface is in its compacted form that is evolved through expansion on gravitational expanding sphere i.e. an expandon cell, *Sec. 5(16)1c, part A3*. In other words, the path-limit Γ_G is unwarped (or elongated) from a gravitational sphere level to the next one based on path-constancy. Noteworthy, any expandon formation of path-length value $+2\hbar$ is along with a contracton, *Sec. 5(2)1c, part c1*, releasing of path-length value $-2\hbar$ towards the center of mass of the mass-body via an H hall package tunnel, *Sec. 5(9)3d, part c*. Ultimately to its straight form along with background time's arrow ΔT_Γ, *Sec. 7(4)1*, and *Sec. 5(16)3b, part c, and paragraph 16*, in flat vacuum texture. Please refer also to *Sec. 5(16)3b, part D,* and *Sec. 8(7)2, part G, item F.*

14) According to above statements and discussion held in, *Secs. 2, 6*, to every space and time location one can attribute a reference frame of six dimensional coordinates (three pairs of path-length of time-space characteristic coordinates) according to *Sec. 2(1)1, paragraph 3C*. It is based on H particle-paths *Delta Effects*, *Sec. 2(1)1b, Fig. 2(3),* path-constancy, *Sec. 2(1)2,* Mirror Image Effect, *Sec. 6(2)3*, counter-currency, *Sec. 3(1)2,* of negapa and posipa mode of motions, relativity-inertia dependence, *Sec. 2(6)2*, conceptions.

15) The H particle-paths of the gravitational sphere expand with the slight preference of SN_r configuration over SP_l (type *R*, in order to generate expandon, *Sec. 5(2)1c, part A*) along with type R_e path-length. Thus, the H particle-paths of the related mass (e.g. left-handed fermions) contracted in a SP_l mode of configuration accordingly, i.e. the slight preference of SP_l over SN_r one in order to form contracton, *Sec. 5(2)1c, part c, Sec. 5(2)1c, part c2*, along with type L_c path-length, *Sec. 5(16)11*, and *Sec. 2(4)4a*. This kind of phenomenon is performed on the surface related to Schwarzschild radius, l_s, *Note 5(16)3a3*; please refer to *Sec. 3(1)2, Figs. 3(4), 3(5), Comment 3(1)2b, Sec. 5(16)2a, Eq. 5(67)15a,* and *Consequence 5(16)2a.*. Therefore, an equilibrium state of *disorder/order* (expansion/contraction) competition is taken place on event zone, *Sec. 5(16)9b, Sec. 5(16)9d, part A*, *B* along with slight preference of the former towards spatial medium, and the latter through the mass medium. Moreover, on this basis at each point on the gravitational sphere, there is a time's arrow, i.e. time of type *R*. Thus, the time's arrow reversal can be regarded of type *L* accordingly. In other words, the radially expansion of gravitational spheres is according to the preference of time's arrow (type *R*) respect to its type *L* reversal, *Sec. 3(1)2, Fig. 3(5)b*, that is not shown in *Fig. 5(8)* for the reason of simplicity, *Notes 5(16)1b, A4, A5*. Noteworthy in case of fixed gravitational (or none expanding) sphere, formally there is no preference of SN_r configuration over SP_l one according to *Sec. 3(1)2, Fig. 3(5)b*, or, in other words, we encountered with static case, *Fig. 3(4)b*, i.e. no time's arrow, *Comment 5(16)1b, A3,* i.e. *SM* configuration as in dark matter, *Proposal 5(15)3b1.* Thus, time's arrow in a dynamical gravitational field, spontaneous action, *Sec. 7(4)2f, part c*, at a distance in new gravitational law is an example of this kind. Moreover, a static quantum mechanical H system has no time's arrow that resulting to spontaneity (or superluminality), *Sec. 8(4).* Noteworthy, according to *Sec. 5(16)11*, the path-length of the field is expanding of type R_e, and that of the related mass is contracting of type L_c characteristic of equal magnitude, but of different sign, *paragraph 21.*

16) According to H particle-paths hypothesis, the gravitational field curved texture of mass-bodies, e.g., galaxies, *Fig. 5(8),* at its ultimate extension tends to a flat texture the same as vacuum space quantized texture, *Sec. 5(16)3b*; to the latter is attributed a background time's arrow, *Sec. 5(16)1c, part c*. In fact, the space fabric is made of the superimposition of the two above-mentioned textures, *Sec. 5(16)3b, part D2*, which obey the spirally expanding in type *R* Universe, *Secs. 5(16)5, 9,* of SN_r configuration, *Sec. 3(1)2, Fig. 3(5)b,* and *Comment 3(1)2b,* along with superposition of related local time, *Note 5(16)1b, A6*. Please refer also to *Sec. 5(2)1c* and *Sec. 5(16)1b, part E.* As a result, the time arrow is proportional to the density of H particle-paths of these textures, i.e. both gravitational and vacuum textures, *Sec. 5(16)1b, part G*.

17) According to *Secs 5(16)5, 5(16)9,* the gravitational spheres expand right-handedly of SN_r configuration, *Sec. 5(2)1c, part c*. Whereas, the matter fermions have left-handed spin that is not shown in *Fig. 5(8)* for the reason of simplicity. Therefore, the gravitational spheres expand left-handedly of SP_l configuration in case of anti-fermions of right-handed spin of SN_r configuration that is in accordance with *CPT* invariance, *Remark 5(16)1b, A4*; please refer also to *Sec. 5(11),* and *Sec. 5(16)2a, Consequence 5(16)2a*. As a result, the gravitational spheres in the both cases of matter and antimatter are counter-current *R and L* types H particle-paths (negapa and posipa) with the difference of right- (group *R*) & left-handedly (group *L*) expansion respectively. *Note 5(16)1b, A*1. Noteworthy, regarding the above discussion, matter and antimatter attract each other. According to [301],"The *CPT* theorem asserts that matter should attract antimatter in the same way that matter attracts matter". Please refer to *Sec. 5(16)9d, part B*.

18) The gravitational potential field and related mass-body are correlated firmly as a unique solid H system, *Sec. 5(2)1d, part B,* along with no aberrative characteristics. In other words, according to *Fig. 5(8),* the expanding gravitational spheres (i.e. Expandons) of mass *M* each of path-length value *h, Sec. 5(16)3g*, are correlated with each other up to consumption of related total mass. Therefore, according to *Secs. 8(7), 8(9),* during a field-mass interaction, e.g. with mass m, this kind of correlation is interrupted. Please refer also to *Sec. 5(2),* in this regards.

19):

A) According to *Sec 4(6)5, Sec. 5(2)1a,* and *Sec. 5(2)1d, part B*, the mass-field interactions, e.g., electromagnetical & gravitational, are spontaneous, *Sec. 7(4)2f, part c*. In other words, the *CF-lines* interactions of the mass *M* field with the mass m main body is instantaneous along with exit of *CI -lines*, and vice versa. Noteworthy, the cells of successive gravitational spheres that are confined in a cone with its apex on an individual Planck area of a Schwarzschild surface, nominating cone-like cavity, *Sec. 5(2)1d, part D*, are propagating at radial finite speed. The intersection of any cone with the reader page is shown in *Fig. 5(8),* by two radial fine dotted lines. Therefore, we encountered with n_s cavities starting on Schwarzschild sphere up to an interaction in spatial medium. Similarly, in case of photon pair as in *Sec. 8(9)1, Fig. 8(1),* a gravitational interaction is depending on these cavities. During an interaction (or measurement, *Sec. 8(7)2*) the interacted cells' tunnel are collapsed spontaneously down to Schwarzschild surface of interacting mass-body as measuring device. Please refer to *Sec. 5(9)3a, b, Fig. 5(5)1* for additional information. Please refer to *Sec. 5(2)1d, part c*. Noteworthy, every cell in a cone-like cavity, *Sec. 5(2)1d, Part D*, has its own reverson, *Sec. 7(5)3b*, that is shielded by related axeon. It constitutes a common H hall package tunnel (constituting of cavity reversons, *Comment 5(16)2a1*) from the apex of the cone-like cavity with the contribution of other preceding cells up to a gravitational interaction. Factually, the cells in a cone-like cavity act as axeons of the cavity reverson, *Sec. 7(5)2b, item D*. Moreover, H hall package tunnel is taken form tangentially between adjacent cells (in the direction of their axes) at contracting S-patch, *Simulation 8(7)2, E5a, item 17 (A).* As the results: based on *Fig. 5(8),* a network of H hall packages for the passage of contractons are made via H hall package tunnels that are evolved through the tunnels that join the nodes on *Fig. 5(8)* to each other. This network can be regarded as framework or Skelton that extends the field in spatial medium.

B) Any main cell in a cone-like cavity, *Sec. 5(2)1d, part D*, as in *Fig. 5(8),* is confined in a quantized H hall packages, *Sec. 5(16)3a,* of path-length value h, *Sec. 5(16)3g,* that is linked according to *Consequence 2(10)1b* to a n_s cell of the Schwarzschild surface cells, *Sec. 5(1)1, Eq. 5(1)1*, of the mass *M*. Thus, the sub-cells are linked to the main cell by sub- H hall package tunnels (or its network). The sub-cell tunnels are overlapped to a single one on the reverson, *Sec. 7(5),* of the main cell. Similarly, all of the main cells on a gravitational sphere also construct a main H hall package of value h. Thus, the sub-cell H hall packages can be considered as stored H hall package, *Sec. 7(4)1, item3,* of related main cell or better to say their related gravitational sphere. By analogy, in case of a mass-body, its fundamental particles have a recombined (or stored) H hall packages of path-length value h with a single reverson, i.e. $K_m = 1$, *Consequence 2(10)1b*. If it is not, the mass-body can viewed as separated non interacting of n fundamental particles (i.e. an ideal case) can be considered as an H system of n particles, each particle is confined in a separate H hall package has an individual H hall package tunnel and a separate reverson, i.e. $K_m = n$ *Consequence 2(10)1b.* As a result, according to above discussion, the main H hall package tunnel of a giant object, e.g. The Earth, can be considered as a canal that joint the Earth reverson to the reverson of the Sun. Moreover, larger canal joints the reverson of the Sun to That of related black hole of the host galaxies & clusters, *Sec. 5(7)8*. Thus, the time travel may be realized via this large canal, if can penetrate the reverax, *Sec. 7(5)3b*, *item II*, of the canal.

20) According to *Sec. 5(16)2c, and Sec. 5(16)3b, part B*, the light speed is apparently lesser than c speed depending on the higher density of gravitational texture respect to vacuum one. However, in the former texture the actual velocity of the light signal is equal to c respect to an observer in a reference frame (as an immutable constant). Please refer also to *Sec. 5(16)1c, part A1.*

21):

A) A particle's main-body, e.g. photon, electron, etc. along its track will be interacted successively by the H particle-paths of track texture of the field (i.e. gravitational medium), or, better to say randomly, *Sec. 8(7)2, part E4,* of equal probability at indistinguishable manner, *Sec. 7(4)2f, parts A, B*), *Sec. 7(1)*, at $d\tau$ time intervals, *Sec. 5(16)1a, Eq. 5(51).* This phenomenon is along with expandons emission by interacting with H particle-paths of H hall packages of the texture of the medium (i.e. a

measurement, *Sec. 8(7)2*), and contracton releasing via H hall package tunnels towards the related mass; please refer also to *Note 6(2)6b1*. The emitted expandons have right-, and left-handed characteristics related to type R_e, and, type L_c path-lengths, *Sec. 5(16)11*, at an indistinguishable manner, *paragraph 7B*, with the slight preference of the former in its gravitational field. In other words, there is a combined texture through superimposition of particle track texture, *Sec. 5(16)3b, part B*, with that of the gravitational field, *Note 5(9)3d, A1*. Therefore, the particle is trapped at any infinitesimal $d\tau$ time interval in the H hall package of the combined texture, and its open ends is grasped by the boundary of the package. In other words, the single direction H particle-paths of a particle related to its spin during particle motion in a gravitational field have indistinguishable configurations (i.e. randomly type *R*, or, type *L* related to e.g. up, or, down spin respectively along with slight preference of the former). Please refer also to *Sec. 7(4)2d, Sec. 7(4)2e*. Noteworthy, the slight preference of expandon of type *R* over type *L* generally imparts a type *R* characteristic to it.

B) An external gravitational, *paragraph 16*, affects the H particle-paths of a particle (or mass-body) main-body up to reach an equilibrium, *Sec. 5(2)1b*, thus constructs the trajectory of the particle (or mass-body), *Sec. 5(16)3b*, by analogy to to General relativity in spatial medium, *Sec. 7(4)3, parts A, B*. The particle during its transfer from a state to next one acquires type *R&L* configurations during stay time intervals ΔT_P successively, Note *8(7)2, E2a.* According to *Sec. 7(4)2f, part E*, ΔT_P depends on both H particle-paths densities of particle's main body and external gravitational field texture.

C) During any stay time interval ΔT_P, an expandon is emitted by particle in spatial medium. It is along with contracton releasing by particle towards the origin of *CMPRF* of the system via common H hall package tunnels, *Sec. 5(9)3d, part c;* please refer also to *Simulation 8(7)2, E5a.*

22) According to *Comment 5(16)1a2*, the gravitational field's potential (or texture) will be extended up to infinity due to path-length constancy, *Sec. 2(1)2,* and splitting characteristic of path-limit Γ (or cell) of expandon (or its cells, *Remark 5(16)1a5*), *Sec. 5(16)1b, part D,* and *Remark 5(16)1b, A5*. The former has some similarities to classical general relativity; whereas, the latter can be compared to ad hoc positive cosmological constant related to dark energy, *Sec. 5(15)2*, please refer also to *Sec. 5(16)1a, part B*.

23) In case of particles at quantum level, please refer to *Sec. 7(4)2e,* and *Simulation 8(7)2, E5a*.

24) Gravity can be regarded as stationary matter-wave counterpart, *Sec. 5(6),* of a mass-body, or, particle at an energy ratio $K_\Gamma \approx 10^{-34}$ of the related mass. Its path-length has non-reversible characteristic, *Sec. 2(4)4b*.

25) According to *Sec. 7(5)3d, part C2*, the right-handedly expanding sphere of type R is relatively more expanding than left-handedly expanding previous one, i.e. type L, in spatial medium. By analogy, any expanding sphere, e.g. type R, in spatial medium is along with contraction in mass medium. Noteworthy, the contraction related to type R expanding sphere is slightly more than that of the type L one within mass medium. Noteworthy, the type *R&L* expanding spheres has right-and left-handed spin in the direction of expansion *Note 5(16)1b, A5*. Moreover, the type *R&L* expanding sphere induce apparent negative and positive potential field, *Sec. 5(16)1b, part F2*, note that, any two adjacent type *R&L* expanding spheres (antinodes) are separated by an interface (or node); please refer to *Simulation 8(7)2, E5a, item 17*.

26) Referring to *Sec. 5(16)3b, part I*, any *WR* (or *WL*) cell or expandon, *Simulation 7(4)2e1,* on the field region of *Fig. 5(8),* based on *Sec. 8(7)2, part E2* has stay time interval $\Delta T_{(pE)}$, *Sec. 7(4)2f, part A*. During the time interval $\Delta T_{(pE)}$ (antinode of *Simulation 3(1)2a*) *WR* (or *WL*) cell is converted to the related reversed handed *WL* (or *WR* cell) respectively along with type *R* (or *L*) expandon emission and *PL* (or *PR*) contracton releasing at the node during infinitesimal time interval $\Delta T_{(pC)}$, *Simulation 7(4)3, E2*, due to a beat *Sec. 7(5)3d, part D,* of gravitational sphere emission. Therefore, the *WR* (or *WL*) cell is followed with its adjacent cell of *WL* (or *WR* cell) respectively, and so on. Noteworthy, according to *Sec. 7(4)2f, part E2*, the cell [or H hall package of path-limit $\frac{\lambda_r}{2}$ in a level or gravitational sphere] conversion to type *R* (or *L*) is along with its expandon transfer to the tangential or radial adjacent cell [i.e. H hall package of path-limit $\frac{\lambda_r}{2}$ in a level at reversed handedness]. Moreover, according to *Note 9(4)6 a,* at ground state merely a *WR* (or *WL*) cell is at expanded mode of half the energy $\frac{1}{2}h\upsilon$. Where $\upsilon = \Delta T^{-1}$, *Sec. 7(4)2f, part A, Eq. 7(26),* is the frequency of the conjugate formation, i.e. inverse of stay time interval.

27) Based on *Sec. 5(7)6*, the path-limit Γ_G in gravitational field can be split to $n\frac{\lambda_r}{2}$ cells in tangential direction, *Sec. 5(16)1a, part A*, i.e. tangential multiplication. Where, $\frac{\lambda_r}{2}$, length of a cell (radial or tangential) is less than Γ_d (path-limit of gravity free spatial medium) in any cone-like cavity, *Sec. 5(2)1d, part D*, or on gravitational sphere respectively as in *Fig. 5(8).* It is analogous to a cell in levels of *Fig. 9(3)a* of *Sec. 9(4)7*, that is not shown in *Fig. 5(8)* for reason of simplicity. Factually, according to *Sec. 7(4)3, part B,* $\Gamma_G = \eta^{-1}\Gamma_d$; where, $a_G = \eta\, a_d$, a_d, a_G are the coefficient constants in free vacuum, and a location of external gravitational field, *Note 1(2)1,* respectively. Therefore, according to *Sec. 9(4)6*, on Schwarzschild surface related to a cone-like cavity, ultimately, we have a single cell that beats, *Sec. 7(5)3d, part D,* to types *R & L* successively, *Simulation 5(16)1b, A1,* at its expanded mode, *Sec. 8(7)2, par G,* i.e. as a aground state*, Note 9(4)6a*. Factually, based on *Sec. 5(16)3b, parts, B, I*, during emission of a sub-cell (e.g. *WR* expandon), from a main cell, in a level to upper one, the *WR* expandon moving at right-handed manner related to our type *R*, i.e. type $R_e - L_c$ Universe, *Note 5(16)9b1*, or vice versa in case of *WL* expandon emission by the main cell. The main cell is transferred in the tangential direction of its initial level in a right-handed manner, *Sec. 5(16)9a*, to the next track texture cell at its reversed-handed form based on mirror image effect, *Sec. 6(2)3*, along with *WL*

expandon emission to upper level moving at left-handed manner (i.e. opposite direction of *WR*) related to type *L*, i.e. type $L_e - R_c$ Universe. In other words, there is a counter-currency mode, *Sec. 3(1)2,* of motion of *WR&WL* expandons at indistinguishable manner, *Sec. 7(4)2f, part B*, and at two opposite tangential directions in a level, *Note 5(16)1b, A5*. Therefore, any cell thus formed obeys the process similar to the main cell as stated above and so one in case of other main cells in a level. In other words, forming a counter-current motion, *Sec. 3(1)2,* of H particle-paths both in radial and tangential direction between the cells at indistinguishable manner. As a result, according to *Fig. 5(8),* the gravitational spheres (or levels) belong to expanding type *R* or contracting type *L* Universe successively with slight preference of the former respect to latter due to successive beats in our matter Universe. Please refer also paragraphs *7B, 21A*. Thus, any main cell (of type *R* or *L*) is splitting successively to *type R &L* sub-cells during stay time interval ΔT, *Sec. 7(4)2f, part A*, at infinite manner up to complete attenuation; please refer also to *Sec. 8(7)2, part E2.*

28) Referring to *Note 7(4)2e2*, and comparing expandon of gravitational field with that of a moving photon, the former has a spindle-like shape during generation as in *Fig. 5(8).*

29) Factually, any cell in a cone-like cavity (or sector, *Sec. 5(16)1b, part G*), *Sec. 5(2)1d, part D,* of *Fig. 5(8)* has equal path-length that emits equal number of contracton towards the center of mass *M*. Therefore, any curved cell or path-length) emits more contractons respect to a rectilinear one, e.g. in a non-gravitating vacuum, in a cone-like cavity or sector of equal tangential length in *3*-space. The same thing is valid in *4*-space. As a result, the number of released contractons depends on curvature of space-time in this regards, *Sec. 2(4)4a*. In other words, the rate of contracton emission depends on the length of a path (or path-length) irrespective of its geometry.

30) The matter wave as in case of mass-body at rest state is confirmed based on *Sec. 8(7)3*, of neutrino oscillations. It can be simulated to gravitational spheres.

31) Based on *Remark 1(1)4*, any expandon cell (*WR or WL*) on *Fig. 5(8)* surface are of type *R* or type *L* respect to the normal to reader page. Better to say the expandon (neutropa) cell have type *R* or type *L* spin configuration respect to the normal of their propagating plane. Moreover, any type of *WR* or *WL* expandon are converted to each other during stay time interval ΔT along with sub-expandon (of type *R* or *L*) emission in spatial medium and *PL* or *PR* contracton releasing towards mass *M* center of mass via H hall package tunnel. *Sec. 5(9)3d, part c*.

32) In case of linearly motion of mass-body *M,* and spherically symmetric rotational motion of mass-body *M* along an axis, according to *Sec. 5(6)1,* we have two separate fields (or de Broglie matter-waves).

A) related to mass-body *M* at rest state as in *Fig. 5(8),*

B) related to moving mass-body *M* as in *Simulation 7(4)2e1, Fig. 7(4)1*. Noteworthy, the shape of *Fig. 7(4)1,* depends on the kind of external (or common) motion of H particle-paths of mass-body *M.* In other words, based on viewpoint of *HPPH*, the latter field (or matter-wave) is similar to concentric rings or tubes around the mass-body *M* trajectory. Therefore, the laws stated in *Sec. 5(16)1b, part G* is also valid for the cells in above cases. Thus, the case *A* related to gravitational and the case *B* to gravitomagnetism, *Sec. 5(2)1c,* phenomena. "*GR* is bound to fail under some circumstances due to its incompatibility with quantum mechanics. In this talk, two examples of possible failures of *GR* that may be confirmed in the very near future are described. The first example relates to the fact that *GR* cannot provide an exact description of any rotating object. In the case of a rotating compact object, *GR* may not be even qualitatively correct. In particular, we will argue that in reality rotating compact objects have a Godel-like vortex core" [635].

33) Based on *Sec. 5(4)2,* the curvature vector T' is related to the gravitational acceleration. Thus, K is related to magnitude of acceleration. Therefore, according to above discussion the direction of T' is related to the mutual contractons emission that releasing from the gravitational sphere cells towards the center of mass of emitting mass *M* through H hall package tunnels, *Sec. 5(9)3d, part* c. In other words, T' is along the singularities, *Comment 5(9)3d2,* of H hall package tunnels.

34) Based on *Note 5(16)2c, B1,* any expandon in a cell of *Fig. 5(8),* in spatial medium have a negative microscopic reverson track within mass *M*. Thus, the microscopic gravity flower is traced within mass *M* medium.

35) Referring to *Fig. 5(8),* the cells of posipa & negapa are drawn based on path-constancy, thus:

1) During cell propagation to upper level, in the first level, the curvature (or delta effect from viewpoint of *HPPH*, *Sec. 2(1)1b, Fig. 2(3*)) of path is diminished in upper levels and becoming nil at long distance (or infinity).

2) The radial distance between successive levels is decreased by increment of the radial distance from mass *M* up to reach continuity of levels.

3) The share of radial respect to tangential path is decreased by radial distance increment in a level that decreased the radial interaction, i.e. force application, with an external mass-body due to decrement of mutual contractons generation, and vice versa. Noteworthy, the radial motion is related to T-symmetry; while, radial one is related to time's arrow.

Simulation 5(16)1b, A1- The tangential motion of successive type *R & L* cells, e.g. as on reader page surface of *Fig. 5(8),* on an expanded sphere *ES* can be simulated with that of a photon motion as in *Simulation 7(4)2e1, Fig. 7(4)1*.

Example 5(16)1b, A1- Considering a ball pendulum that is hanged by a thread from a frame a twisting merely to right- and left-handed directions successively. Supposing in its right-handed part of its twisting emits n_s signals (*WR* and *WL* expandons) along with n_s extinction nodes (*PL* or *PR* contractons) in half of it's period (or half of a beat) In its left-handed rotation it emits n_s signals ($\overline{WR}$ and $\overline{WL}$ expandons) along with n_s extinction nodes ($\overline{PL}$ or $\overline{PR}$ contractons) in other half of its period (or half of a beat). Thus, the pendulum continues the above process during its other periods (or beats). In case of mass-body, the emission of expandons and contractons can be regarded during infinitesimal stay time intervals, *Sec. 7(4)2f, part A*, as indistinguishable at longer time due to superimposition, *Note. 7(4)2f, B1*.

Consequence 5(16)1b, A1- In macrocosm, in case of mass-bodies, the radius r (or separating distance) of interacting mass-bodies, *Sec. 5(1)1*, is restricted by Schwarzschild radius l_s. Therefore, r varies from l_s of mass-bodies up to infinity. In other words, the right- and left-handed H particle-paths at their compactified feature, *Sec. 2(1)1d*, on Schwarzschild surface with slight preference of former in our matter Universe expand in the form of gravitational surface up to infinity.
In macrocosm, in case of a particle of rest mass is confined in an H hall package of path-limit Γ, *Sec. 5(16)3b, parts A, D2*. Therefore, its interacting distance r is restricted to the path-limit Γ_d, *Sec. 7(4)3, part H*, through normal vacuum space. "Sundrum's suggestion: the graviton string has a size of *0.1 mm*". "Gravity gets very weak at separation less than 0.1mm"[468]. Please refer also to *Sec. 5(16)1c, part A3*, *Simulation 8(7)2, E5a*, and *Sec. 8(8)2, paragraph 9*.

Consequence 5(16)1b,A2- The H particle-paths in the mass medium, and on Schwarzschild surface of radius l_s are in their compactified forms. During an expanding sphere generation on the surface, the H particle-paths of each n_S cell, *Sec. 5(1)1, Eq. 5(5)1*, are profiting by all of their 10 dimensions (or space and time degree of freedoms) mentioned in *Note 2(1)1d1*. Please refer also to *Sec. 5(7)6, Sec. 5(16)2a*, and *Sec. 8(8)2, paragraph 9*.

Consequence 5(16)1b, A3- The distinct distance and time interval between spheres *ES1, ES2, ES3*, ….is decreased in an external gravitational field, *Sec. 7(4)2f, part D.* Noteworthy, any gravitational sphere in each of the position *1, 2, 3,...* is handedness reversal of its neighboring sphere. The time interval between any two neighboring gravitational spheres emission on the surface of Schwarzschild can be coincides with the stay time interval, *Sec. 7(4)2f, part A*, of the related mass-body that generates the gravitational spheres. In addition, the distinct distance between is diminished down to a continuity of gravitational spheres, by analogy to case of principal orbits of atoms. Please refer also to *Proposal 5(16)1c, A2*, and *Sec. 5(16)1a, part B*.

*Note 5(16)1b, A*1- Based on bi-Universe hypothesis, *Sec. 5(16)9*, the matter gravitational spheres expand at right-handed manner in spatial medium, *Sec. 7(4)3, part A*. In other words, if the gravitational ground sphere expands at right-handed manner, i.e group *R*, its successive next gravitational ground sphere expands at left-handed configuration, i.e. group *L*, with sligth preferenence of the former, nominating SN_r configuration. Alternatively, in case of antimatter, i.e. if a gravitational ground sphere in this case expands at left-handed manner, i.e. type *L*; the next one expands at right-handed configuration, i.e. type *R*, with slight preference of the former nominating SP_l configuration.

Note 5(16)1b, A3:
The outer region of event zone or wave-like part of the mass consists of two parts according to the motion of H particle-paths as following:
A)-The part that we usually named as mass body in which the radial motion of H particle-paths can be regarded as reversible motion, *Secs. 2(1), 2(3);* therefore, the famous relationship of $E = mc^2$, *Eq. 2(33)*, is applicable to it. Please refer also to *Sec. 5(16)2a.*
B)- The part that consist of the field in which the radial motion of H particle-paths is single direction, or, in other words, the total part of that is consisted of energy or zero rest mass named as potential energy, *Note 5(4)1b.*

Note 5(16)1b, A4- Through superposition of any two adjacent gravitational spheres of *Fig. 5(8)* at two opposite direction, a rough imagination of reversible motion of H particle-paths of *SM* configuration, *Remark 3(1)2a*, in an indistinguishable manner can be obtained that is not shown in *Fig. 5(8)* for the reason of simplicity. Factually, there is a slight preference of *SN* configuration over *SP* one in spatial medium of our expanding Universe, nominating SN_r configuration, *paragraph 15*. There is also a slight preference of *SP* configuration over *SN* one in related mass medium at equal magnitude, *Sec. 5(16)11* of spatial medium, nominating SP_l configuration. Please refer also to *Sec. 8(9)1, Fig. 8(1).*

Note 5(16)1b, A5- The right-handedly expansion, *Sec. 5(16)5*, of gravitational sphere implies that there is a preference of its type *WR* expandon cells over type *WL* ones. Noteworthy, according to *Sec. 5(16)5*, any type *R* right-handedly expanding gravitational sphere is followed with a successive type *L* left-handedly expanding gravitational sphere with slight preference of the former. Thus, forming totally a right-handed expansion of gravitational field of a mass-body in our matter Universe. Moreover, the same scenario is valid within mass medium, *Sec. 7(4)3, part D*, at reversed handed manner.E.g. during emission of expanding gravitational sphere of type *R* (or *L*), there is a contracting beat at type *L* (or *R*) within mass medium along with a right- (or left-handed) spirally contraction that is accompanied by a type *PL* (or *PR*) contracton releasing towards *CMPRF* of mass medium; please refer also to *Simulation 7(4)2e1*. Resuming during expanding mode, *Sec. 8(7)2, part G,* of a mass-body beat, *Sec. 7(5)3d, part D*, the expanded cells are appeared on a gravitational sphere, *Fig. 5(8),* along with spatial expansion and positive energy related to expandons due to dark matter consumption, *Sec. 8(7)2, E5*. Thus, during its contracting mode of the beat, the contractons are released towards related mass-body Schwarzschild sphere through H hall package tunnels, *Sec. 5(9)3d, part c*, along with mass contraction related to negative energy of gravitational attraction. Please refer also to *Sec. 8(7)2, E5 item9.*

*Note 5(16)1b, A6-"*One of the central problems in interpretation of quantum theory is the duality of time evolution of physical systems:

1. Unitary evolution by the Schrödinger equation
2. Nondeterministic, no unitary change during measurement of physical observables, at which time the system "selects" a single value in the range of possible values for the observable. This process is known as wave function collapse. Moreover, the

process of observation occurs outside the system, which presents a problem on its own if one considers the universe itself to be a quantum system. This is known as the measurement problem"[617], *the central problems*.

The case *1* related to unitary evolution can be attributed to background time's arrow; while, the non unitary change during the measurement can be related to local gravitational time due to gravitational spheres of type *R & L , items 15, 17.*

Comment 5(16)1b, A1- In fact, the H particle-paths of a mass-body moving at c speed and according to *Sec. 2(10),* the forwarding, ΔT_F and backwarding ΔT_B, time's arrow, *Sec. 5(16)7*, intervals obey the *Eqs. 2(116)-(118);* moreover, the average time's arrow, ΔT_{FB}, can be obtained according to *Eq. 2(119),* along its related spatial expansion in this respect.

Comment 5(16)1b, A2- Recently, reported that radio Doppler data generated by *NASA*'s Deep space Network (*DSN*) from the pioneer 10 and 11 spacecrafts indicate apparent anomalous constant spacecraft acceleration with a magnitude $-8.5\times10^{-8}\,cm\,s^{-2}$ directed toward the Sun [151]. According to above statements this can relates somehow to five possibilities as following:
A) Tangential time ΔT_t increases along with decrease of radial one, i.e. ΔT_r. In fact, ΔT_t and ΔT_r are conventional measures to demonstrate the deformation of gravitational field H particle-paths from radial to tangential direction and its related effect on a mass-body [or transmitted photon (signal)] H particle-paths in that field.
B) The total time's arrow related to gravitational field decreased and smoothen to the vacuum background time's arrow, *Sec. 5(16)1c, part c* accordingly; please refer also to *Sec. 5(16)7c*; therefore, correction due to background time's arrow must be considered.
C) "For a signal passing through a medium with matter density, the rate of frequency change with matter density, the rate of change of frequency with distance depends linearly on frequency and matter density roots" [152]. Assuming matter density as interplanetary dust density, the frequency change of a signal can be related to the interactions of its single direction H particle-paths with that of reversible one of the dust, *Sec. 5(16), Sec. 5(16)2c*, in which the refractive index of the dust η, *Eqs. 5(68)1, 5(68)5,* must be taken into account instead matter density.
D) "Clock acceleration between coordinates or Ephemeris time and international atomic time"[307].
E) According to *Sec. 7(4)2f, part D*, there is a slight induced gravitational field of a mass-body, e.g. an satellite, in an external gravitational field, e.g. the Sun, that cause an slight additional attraction towards the source of the external field. Therefore, the force of gravity deviates from the traditional Newton value.
F) Please refer to *Consequence 5(15)1b.*
The two cases *A, B* have H particle-paths interpretation basis; therefore, having the same issue, i.e. tendency of vacuum texture, *Sec. 5(16)3,* fabric toward flatness; please refer to *Sec. 5(16)1b, part A, paragraph 16.*

Comment 5(16)1b, A3- Factually, the gravitational spheres expand spirally of SN_r configuration. Thus, there is a preference of SN_r over SP_l one in the cases of mass-bodies at rest state that induced related gravitomagnetism effect besides of gravitational effect; please refer also to *Sec. 5(2)1c, part A*, *Sec. 5(6)2, Note 5(16)1b, A5*.

Comment 5(16)1b, Aa- In case of continuity of spatial medium traditionally according to keta-e-sharrif: "Do they not then look up to heaven (sky) above them how we have made it and adorned it and ***it has no gaps***?"[110]A *Surah 50, verse 6*.

Remark 5(16)1b, A1 - Each of these quantized units (or cell) according to *Sec. 4(2), Fig. 4(3), b, g,* can be assumed analogous to a loop at opposite spins. Therefore, the gravitational field around mass *M* can be considered as an accumulation of these loops separated by expanding gravitational spheres that are expanding with the latter in a dynamical manner. Moreover, negapa and posipa are interchanged through the cells radially and tangentially at c speed. Each cell can be considered as superposition of negapa posipa loops, i.e. types R_e and L_c of SN_r and SP_l configurations, *Sec. 5(16)11,* respectively, i.e.a type $R_e - L_c$ Universe, *Comment 5(16)9b3*, that are not shown in, *Fig. 5(8)*. These can be related to H particle-paths population density in that cell, i.e. *b, g,* illustrations of *Fig. 4(3)* in the direction toward the reader page assumed as tangential motion direction respectively. Therefore, the H particle-paths related to each cell have also an indeterministic feature as in, *Sec. 8(7), Fig. 8(1).* Please refer also to *Secs. 5(2)1c, 7(4), 7(5).* Noteworthy, according to *Sec. 5(2)1c*, in each of these loops (or cells), there is a slight preference of SN_r configuration over SP_l one. In other words, each loop has a total spin of SN_r configuration due to excess of the latter over SP_l one respect to the radial direction of expanding gravitational sphere, i.e. expandons, *Sec. 5(16)1c, part A3.* By analogy to case of photon, *Simulation 7(4)2e1*, any cell is constituted of WL, or WR types of expanding characteristic at an indistinguishable manner during a stay time ΔT, *Sec. 7(4)2f,* in an H hall package position. In other words, WL expandon changed its configuration to WR (or vice versa) successively during times interval ΔT at a position (or state). Please refer also to *Sec. 5(16)1a, part B,* and *Simulation 8(7)2, E5a, item 12*. Noteworthy, based on above discussion, and according to *Comment 5(16)9b3*, in case of antimatter, we encounter with type $L_e - R_c$ Universe with group *L* gravitational spheres, i.e. the gravitational sphere expand at left-handed manner of SP_l configuration in spatial medium, *Sec. 7(4)3, part A.* Therefore, its expandons by analogy to that of matter Universe are shown conventially as $\overline{WL}$ & $\overline{WR}$ expandons, *Note 7(4)2e1*. Similarly, its contractons

contracts within mass medium of SN_r configuration with $\overline{PR}$ & $\overline{PL}$ symbols respectively, *Example 5(16)1b, A1*. Please refer also to *Simulation 8(7)2, E5a, and Note 5(15)2c1,* for additional information.

Remark 5(16)1b, A2 - Referring to *Sec. 2(4)2,* $\delta S_g, \delta S_m$, for an isolated mass m is a constant quantity. But, under influence of an external gravitational field of mass *M*, according to strength of external field, or, better to say external path-length density and its variation in each point of trajectory of mass m, δS_g and δS_m of the latter increase and decrease respectively in order to reach an equilibrium, *Sec. 5(2)1b, Fig. 5(2).* At equilibrium state, mass m acquire external H particle-paths in the form of quantized path-length unit of h value, *Sec. 5(16)3g*, and release its reversed handedness, *Sec. 5(16)9b*, according to the Mirror Image Effect, *Sec. 6(2)3,* along with *WL* expandon moving at left-handed manner related to type *L*, i.e. type $L_e - R_c$ Universe. In other means, the time's arrow related to external medium (vacuum) of mass m increased and the time's arrow in internal medium of mass *M* reversed accordingly, i.e. the external clock of mass m is slow down due to time's arrow increasing. Moreover, the entropy of external motion of mass m increase toward disordering along with decrease in its H particle-paths internal motion entropy toward ordering at the same magnitude; please refer to *Sec. 5(16)9d, part A*. Therefore, action variation, *Sec. 2(4),* in each $d\Omega$ of 4-space volume variation has a hard link with related entropy variation in that space location.

Remark 5(16)1b, A3– The gravitational spheres constitute the gravitational potential of mass-body *M*. "it is well known to physicists that electromagnetic signals are not bent or slowed by the force of gravity, but by passage through a gravitational potential field. A potential field slows the rates at which clocks tick, produces gravitational red-shift, bends light, and retards radar and radio signals [409] *the physical meaning*.

Remark 5(16)1b, A4– In a type *R* matter Universe of spatial SN_r configuration the right-handed neutrino of SP_r configuration is not seen. Factually, up to now in such a Universe the fermion, e.g., neutrino, electron, proton, has SP_l configuration. Therefore, the fermions of right-handed spin are in fact left-handed due to reference frame transformation to a higher speed than that of right-handed fermions; please refer to *Sec. 1(5), Remark 1(5)1.* In other words, the SN_r, SP_l are in accordance with Mirror Image Effect, *Sec. 6(2)3,* which do not match with other configuration such as SP_r one. Please refer also to *Sec. 5(2)1c.*

Remark 5(16)1b, A5- The gravitational field potential is attenuating down to vacuum gravity free texture at infinity. According to *Proposal 5(2)1a1*, both expandon front *CF*-lines of gravity and gravity free interact with H particle-paths of mass-body. Based on *Sec. 5(2)1*, the former curved front leading to gravitational attraction. While, the latter of rectilinear front has no attraction or repulsion effect at short time and distance, But at long time and distance, due to expansion characteristic of spatial medium related to vacuum quantized spatial H hall packages generation, the vacuum medium has repulsive characteristic due to dark energy, *Sec. 5(15)2*. During the motion of a particle (or mass-body) in gravitational field and normal vacuum media, the stated above mutual interactions depending on H particle-paths population densities of the media and particle affect the stay time interval of the particle, *Sec. 7(4)2f, part A*. It is along with successive W_R & W_L expandons formation as particle matter wave, *Simulation 7(4)2e1*. Please refer also to *Remark 5(16)1b, A1,* and *Sec. 7(4)2f, part E.*

B) Gravitational radiation

Radiation of electromagnetic energy differs from that of gravitational. The former can be split by atoms and molecules, *Sec. 9(3)1, Eq. 9(22),* to posipas and negapas, *Sec. 1(5),* separately; moreover, it recombined as photon radiation. Whereas, the latter is based on the mutual exchange (or displacement) of H particle-paths of mass-field interactions, *Sec. 5(2)1b, Fig. 5(2)*, according to Mirror Image Effect, *Sec. 6(2)3*, *Example 5(16)1b, B1,* and field-field interactions.
According to *Eq. 5(46)*, we have:

$$A = \frac{\lambda_s}{\lambda_r} = \frac{l_s}{r} = \frac{GM}{c^2 r} \quad , \text{ Note 5(16)1b, B1} \qquad 5(67)$$

Where, λ_s, λ_r are the wavelength related to gravitational ground sphere, i.e. Schwarzschild surface, and gravitational sphere at radius r respectively.
According to *part A*, *Fig. 5(8),* and *Eq. 5(67),* the λ_s (or λ_r) depends on mass *M*; moreover, λ_r obey the path-constancy, *Sec. 2(1)2*, and its related path-length is equal to that of λ_s and independent of r.

Alternately, the notion of gravitational radiation, if existed, differs from electromagnetic one, *Secs. 5(16)1a, 5(16)1d*. Since the latter is constituted of two different single direction open-end H particle-paths of *R&L* handedness, e.g., photon, *Sec. 4(4),* related to interacting fields of negative and positive charges; whereas, the former is expanding counter-current closed-end H particle-paths, i.e. gravitational expanding spheres related to mass nominated Expandon, *Sec. 5(16)1c, part A3*. Please refer also to *Sec. 2(16)1b, Fig. 5(8).* According to [299], abstract, "We report on a search for gravitational-wave bursts in data from three *LIGO* interferometric detectors during third science run. The real targets sub-second burst in the frequency range *100-1100Hz* for which no waveform model is assumed, and has sensitivity in term of the root-sum-square (*rss*) strain amplitude of $h_{rss} \sim 10^{-20} \cdot H_z^{-1/2}$, no gravitational-wave signals were detected in the eight days of analyzed data". *LIGO* is the abbreviation of laser interferometer gravitational wave *LIGO* is the abbreviation of laser interferometer gravitational-wave observatory.

Based on the above discussion, the whole photon package can be detected by atoms; whereas, expandon, *Sec. 5(16)1c, part A3,* as a closed expanding H system, until now cannot be detected. Noteworthy, Expandon absorbing partially by the mass-bodies during a gravitational interaction as a *CF* force-line, *Sec. 5(2)1a,* along with equal exit of impulsion-line *CI* as energy loss, *Sec. 5(2)1*. According to [300], characteristic, "Although gravitational radiation has not yet been unambiguously and directly detected, there is already significant indirect evidence for its existence. Most notably, observation for the binary pulsar *PSR B1913+16*, whereas is though to consist of two neutron stars orbiting rather tightly and rapidly around each other, have revealed a gradual inspiral at almost exactly the rate which should be predicted by general relativity. According to general relativity, this system should emit gravitational radiation which carries off energy at a specific rate, which should in turn cause the orbit decay at a rate roughly *7mm* per day". On the basis of H particle-paths hypothesis either isolated mass-bodies or interacting ones lose energy (or mass), in the form of Expandon, and *CI* impulsion-line, *Sec. 5(2)1*, respectively without resorting to gravitational radiation, *Sec. 5(9)3*. In other words, the gravitational field contains gravitational potential energy through counter-current H particle-paths of expanding gravitational sphere (or Expandon) contrary to general theory of relativity. "Changes in gravitational field whether themselves of wave-like character or not, are distinctly different phenomenon from gravitational waves of *GR*. Moreover, gravitational fields and changes in those fields (due to acceleration of a source mass) all emanate from the source of gravity. By contrast, gravitational waves emanate from a target of gravity as its forced to accelerate for any reason, as in case of a supernova" [437]. Gravitational waves and forces variation confused. According to *Sec. 5(2) 1c* gravitomagnetical waves, moving at superluminal speed through tunnels of H hall packages perforated within vacuum texture. These waves are produced during interaction of elongated expandons, *Sec. 5(2)3b*, and contractons at the case of binary pair, *Sec. 5(2)1d*. However, the gravitational field expandons propagate through vacuum at finite speed less than light velocity, *Sec. 5(9)3c.* Please refer to *Secs. 4(6)4, 5*. "Only gravitational waves (changes in gravitational potential propagate at light speed", "But, whether gravitational waves are electromagnetical phenomena or not is a separate issue" [439] *Second Round of Responses*. According to [300], gravitational waves transmit energy, "Within parts of the scientific community there was initially some confusion as to whether gravitational wave could transmit energy as electromagnetic wave can. This confusion came from the fact that gravitational waves have no local energy density –no contribution to the stress-energy tensor. Unlike Newtonian gravity, Einstein gravity is not a force theory. Gravity is not a force in general relativity; it is geometry. Therefore, the gravitational field was not to contain energy, as would a gravitational potential. But the field can most certainly carry energy as it can do mechanical work at a distance". The problem arises when by simulation to electromagnetic wave, and contribution of a symmetric stress-energy pseudo-tensor (subjected to general criticism) for the weak gravitational field in vacuum, an equation of gravitational field in vacuum is arise for Einstein gravity. Please refer to [1] *part 101*, according to that the gravitational field propagates at light speed in the vacuum similarly to electromagnetic field.

Summering, according to H particle-paths hypothesis, *Sec. 5(2)1d*, there is two kinds of gravitational propagations as following:

1) Gravitomagnetical waves propagate instantaneously as in case of virtual particle in electromagnetical interactions, *Sec. 4(6)5*. It relates to mass-field interaction.

2) Changes of gravitational potential fields (or expandons). They are propagating at finite speed less than light speed through vacuum texture, *Sec. 5(16)3b, part A*. It relates to field-field interaction, *Sec. 5(2)1d, Example 5(2)1d, c1*

Example 5(16)1b, B1- Supposing two masses *M* & m are attracted by their gravitational interactions. According to *Sec. 5(2)1a*, the *CF-lines* of mass m gravitational field interact of mass *M* or vice versa. Thus, producing *CI-lines* in both masses up to reach equilibrium, *Sec. 5(2)1b*. At equilibrium stage, two masses are rotating around an axis normal to the plane of rotation at center of their masses, i.e. axis of non-rotating frame, *Sec. 5(9)3b*. Please refer also to *Sec. 5(9)3a*. According to *Sec. 5(2)1c*, to any mass-body at motion, one can imparts a gravitational field. In other words, the expanding spheres (or expandons, *Sec. 5(16)1c, part A3*) of mass *M* (or m) of SN_r configuration (that is equivalent to partial charge $-\delta|e|$) interacts with main body of mass m (or *M*) of SP_l configuration (that is equivalent to partial charge $+\delta|e|$). Therefore, producing gravitomagnetical wave based on field-mass interaction. As a result, the total mass of orbiting masses m *& M* system losses energy (or its equivalent mass) in the form of such an interaction, *Remark 5(16)1b, B1*, that propagates instantaneously, *Sec. 5(2)1d.*

Note 5(16)1b, B1- In this relationship matter is viewed as macroscopic, *Sec.2,* i.e. regarded as point-like or corpuscular but at the case of microscopic one ,i.e. wave-like as *Figs. 3(4), 3(5), 4(4),* we encountered with an alternative case completely different from the former that must be investigated accordingly. Moreover, to each wrapped or contracted H particle-path in a, n_G group, *Eq. 5(1)*, at λ_s, wavelength on the Schwarzschild surface, we can appropriate a Planck area, *Eq. 5(37)2.* Moreover, on Schwarzschild surface, i.e. $r = l_S$, the wavelength $\lambda_r = \lambda_S$ is equal to Planck length l_P. In other words, λ_S is the separating distance between any two adjacent H particle-paths of n_G.

Remark 5(16)1b, B1– To have a radiation as in case of electromagnetic one, we must have a field-field interaction, *Sec. 4(3)1*, *Consequence 4(3)1,* $B1$, that is not possible in case of expandon-expandon interaction of the same sign. As a result, only the variation of expandon density must be regarded as a field variation, *Example 5(16)1b, B1*. Therefore, there is no gravitational radiation (i.e. the same as electromagnetic one that propagate at c speed) through normal vacuum. As a result, the magnitude of spontaneously gravitational interaction depends equivalently on the propagation speed generated expandons, i.e. gravitational field, through normal vacuum (texture, *Sec. 5(16)3b, part A*) at light speed, that is confirmed by absorbing the binary pulsar *PSR 1913+16* decaying orbit. In other words, the amount of contractons, *Sec. 5(2)1c, part* c, generated due to expandon propagation depends on the speed of generation of the latter in each of the binary counter-parts. Therefore, the interaction of expandons of one counterpart of pulsar with the main body's contractons of other one, (i.e. field-mass interactions) leads to instantaneous, *Sec.*

7(4)2f, part c, interacting forces through H hall tunnel between the two mass-bodies. It leads to the energy loss of the total system. "But in any field theory, radiation is intimately related to the finite velocity of field propagation, and the orbital changes due to gravitational radiation can equivalently be viewed as damping caused by the finite propagation speed" [428]. Note that, vacuum quantized texture, *Sec. 5(16)3b, part A*, put a limit on the rate of expandons generation, i.e. c speed. In other words, without this limitation the expansion is superluminal as in case of the big-bang era, i.e. inflation, through abstract vacuum, *Sec. 5(16)3h*. Therefore, we encountered with a dense population of expandons population and contractons, i.e. strong gravitational field, in this era.

C) Ratio factor A

The ratio A has a physical meaning in case of a small body m located a distance r from main body M center it express the kinetic energy needed for escape of the mass m from the mass-body M field, as a fraction of the small body's (m) rest energy. The ratio, A is a kind of binding energy fraction, it has also the following physical meaning [27]:

Light bending angle $= 4A$ 5(67)1

Orbit speed $= A^{1/2}$ 5(67)2

Escape speed $= (2A)^{1/2}$ 5(67)3

Scale factor, $s = (1-2A)^{1/2}$, *Note 5(10)1b* 5(67)4

D) A proposed skin growth mechanism simulation of expansion of gravitational surfaces (or expandons)

As an alternate mechanism of expansion of gravitational field, there is also a proposed mode of expansion by analogy to living body's skin growth. According to that, each cell of skin is divided to two or more cells. Therefore, referring to *Fig. 5(8),* the expandon on the event zone of a black hole, or, Schwarzschild surface of a normal mass, i.e. $n = 0$, has n_s (or n_G), *Sec. 5(1)1*, cells. It has on the first principal state beyond ground state, i.e. $n = 1$, $2^1 n_s$ cells (or correlated sub-states). Thus, expandons in the n^{th} principal state will be constituted of $2^n n_s$ cells (or correlated sub-states). According to this proposal, any expandon during its expansion is passing through lowest principal state, $n = 0$, on Schwarzschild area up to $n \to \infty$; please refer also to *Comment 5(16)1a2*. Noteworthy, expandon on each of its principal states has the path-length value $2\hbar$, *Sec. 5(16)3g*, just after the measurement (or interaction), *Secs. 8(6)2c, 8(7)2*; please refer also to *Sec. 5(7)7* in this regards. Factually, before the measurement the successive expandons on each level (or state) are correlated together within an H hall package as a unique H system, *Sec. 8(5).*

E) Time's arrow increment due to a gravitational field

According to *Sec. 5(16)1a, Remarks 5(16)1a4, a5*, the whole gravitational field of a mass-body *M* can be regarded as a unique H system, *Sec. 8(5)*, of path-length value h, *Sec. 5(16)3g*. Therefore, during an interaction (or measurement, *Sec. 8(7)2*) of the field *M* with the mass-body m, *Sec. 5(2)1*. An H hall quantized package, *Sec. 5(16)3a*, of path-length value h takes form. As an example, a satellite during its rotation in the gravitational field of the Earth *M* acquires successively the time's arrow in quantum scale in units of ΔT_Γ, *Sec. 7(4)1*, as relativistic time due to the gravitational field of the mass-body *M*. The time's arrow increment through spatial medium of gravitational field is along with its reversal at equal magnitude through the related mass medium, *Sec. 5(16)11*.

F) Time's arrow, T-symmetry and potential scenario in levels of gravitational spheres

F1) Time on the level of gravitational spheres

A) Events at the same time form a manifold, i.e. a gravitational sphere or level, which is a snapshot of space at one instant.

B) The successive gravitational spheres (or levels) can be analogous to time elapsed along world line between earlier and latter events.

"The simplest form of matter- the big lumps that make galaxies- can be represented by worldlines that trace out the history of each galaxy through time. In standard models, the galaxies recede from one another and this is represented by a spreading apart of the galactic world line."[459] *Metrical structure and matter fields*. The world line according to combination of cases A, B can be analogous to some extent to the galactic worldline at small scale. According to above statements, and referring to *Fig. 5(8),* we have:

1) In our matter Universe, the $\Delta T_{G(R)n}$, or, $\Delta T_{G(L)n} = T_n$ nominating time or time reversal (*T*-symmetry) is the stay time interval , *Sec. 7(4)2f, part A*, of an gravitational sphere at an expanded form related to two types *R*, or *L* configuration in n^{th} with slight preference of the former respect to the latter one during a transition. Therefore, the transition of a sphere from a level, e.g. n, to the next one is during the infinitesimal time interval $\Delta T_{G(R-L)n} = T_n - T_{n+1}$ nominating time's arrow in spatial medium and $\Delta T_{G(L-R)n}$ within related mass medium is nominating time's arrow reversal; please refer also to *Sec. 5(16)1b, part A, case 2(IIIA), Comment 7(4)2e2*, and *Sec. 8(7)2, part G* and *Sec. 5(16)1b, part F2.*

2) By analogy to *Note 8(7)2, E2a*, during a beat, *Sec. 7(5)3d, part D*, the gravitational sphere along with its n_S cells, *Sec. 5(1)1*, appear at once during an infinitesimal stay time interval $\Delta T_{G(R-L)0}$.

3) If the n^{th} gravitational sphere level is of type *R* configuration, the two adjacent spheres, i.e. $n-1, n+1$ are of type *L* or vice versa.

4) According to *case1*, we encounter with *T*-symmetry, and time's arrow in levels of gravitational spheres. The effect of gravitational potential in a location depends merely to time's arrow interval in each level, *Sec. 5(16)1b, part F2.*

F2) Potential transformation

"If we use the freedom to add the constant $K(t)$ to potential U to transform to the new potential field U', we arrive at the simplest example of a gauge transformation:

$U' = U + K(t) = -GM/r + K(t)$

Both fields, U and U' give the same observable forces. In so far as determining the gravitational forces on bodies is concerned, we can use either U or U'. The choice does not matter. That is taken to signify that the two potential fields U and U' represent the same reality."[459] *what is a gauge freedon?*

Where:

- M , the mass of a macro-body inducing a force $F = \frac{GM}{r^2}$ on a test mass unit at distance r from the mass M .

-$K(t)$, "the constant K must be the same everywhere in space only at one instant of time. Its value can change from moment to moment. So at time t=0, we may have K=0; or at t=1 we may have K=27; and so on. To indicate that K may vary with time t but not spatial position."[459] *what is a gauge freedon?*

According to *Sec. 7(5)3d, part D*, the time and time reversal in *T*-symmetry, *Sec. 2(3)3*, is affecting the $K(t)$ due to type *R&L* of expandon cells in each gravitational sphere. In other words, It is relating to a reversible self-erasing potentials of magnitude up to $\pm$ values of $K(t)$ in a location through a cycle of beat due to reversible path-length, *Sec. 2(4)4b*. While, the potential U of irreversible characteristic related to time's arrow in that location due to irreversible path-length. Noteworthy, the type *R* gravitational sphere induce negative potential; while, the type *L* positive one. Moreover, the potential related to time's arrow in our matter Universe is of negative kind.

As the results:

I) Potential GM/r is depends on the δN_g number, *Sec. 2(4)4a*, of expandons or contractons sources on *CF*-lines of the unit of mass $m = 1$ effects on mass *M*, or vice versa, *Note 5(2)1e1*. In other words, the *CF*-lines of unit of mass are compensated during its interaction on mass *M*, S*ec. 5(2)1b.* Thus, forming appropriate number of H hall package tunnels, *Sec. 5(9)3d, part C*, that are equivalent to force F application due to mutual contractons exchanges between mass-body M and mass unit via these tunnels. Therefore, the additional potential $K(t)$ has no effect in this regards.

II) According to above discussion, the magnitude (or intensity) of an expandon source depends on the magnitude of related mass M ,$(M >> m = 1)$, or m . There are a mutual equal number δN_g of contractons releasing at equilibrium stage, *Sec. 5(2)1b*, between the two interacting masses $M \,\&\, m$, or better to say due to mutual contractons releasing by related black hole of host galaxies and clusters, *Sec. 5(7)8*.

G) A Mechanism of field propagation

G1) General features

The statements as in *item 16* of *Sec. 5(16)1b, part A,* have analogy with "Einstein's general theory of relativity requires that gravitational fields and space-time be one and the same mathematical objects, this means that space-time itself is also subject to the kinds of uncertainty required by quantum systems"[608]. Factually, according to *HPPH* the gravitational field and vacuum space quantized texture are composed of H hall packages, *Sec. 5(16)3,* of path-length limit Γ_G , and Γ_d respectively. According to *Sec. 7(4)3, part A, Eq. 7(31),* we have:

$$a_G \cdot \Gamma_G = a_d \cdot \Gamma_d = c \qquad 5(67)4a$$

Where:

a_G, a_d, are the values of coefficient a in gravitational field and gravity free vacuum respectively, *Note 1(2)1, item A(II).* Moreover, the coefficients a_G, a_d, are proportional to inverse of stay time interval, *Sec. 7(4)2f, part A.* T_G, T_d, of related H hall packages in one of its type *R&L* configurations. In other words, according to *Sec. 7(4)3, Eq. 7(30):*

$$\frac{\Gamma_G}{\Delta T_G} = \frac{\Gamma_d}{\Delta T_d} = Cons. \qquad 5(67)4b$$

Factually, ΔT_G (or ΔT_d) in type *R* configuration has time arrow and in type *L* time arrow reversal characteristics. Thus, the algebraic sum of the two stay time intervals *R&L* can be visualized as effective time arrow ΔT_G , i.e. slight preference of type *R* over *L* configuration in our matter Universe. Please refer also to *Sec. 5(16)7e*. Noteworthy, in case of particle and sub-cells on gravitational spheres, the time arrow and its reversal fluctuation respect to time's arrow of the whole media is negligible; please refer also to *Sec. 8(7)2, E5*. Moreover, each type *R* (or *L*) cell or sub-cells on a gravitational sphere obey the *Eq. 7(10)* as following:

$$\Delta E_G \cdot \Delta T_G = h \qquad 5(67)4c$$

Where, ΔE_G is cell energy and ΔT_G the stay time interval, *Sec. 7(4)2f, part A*, of an expandon in a cell. The ΔT_G in a cell, e.g. of type *R* configuration, can be viewed as time arrow, *Sec. 5(16)7*, and at type *L* time arrow reversal, *Comment 5(16)1b, A1*;

please refer also to *Simulation 8(7)2, E5a, item 17*. According to *Sec. 2(4)4a*, during a complete beat, *Sec. 7(5)3d, part D*, in a cell a couple of *PR & PL* contractons (i.e. aggregated contractons, *Sec. 7(5)3d, part B*) of spin $2\hbar$ is released towards the source (or mass-body center of mass) via H hall package tunnel, *Sec. 5(9)3d, part c*.

According to *Note 2(4)4c*, $\frac{\delta N_g}{\delta t}$ can be regarded as expandon variation number per time unit, it is equivalent to an expandon energy during stay time interval ΔT_G, i.e. ΔE in a cell. According to *Eq. 7(5)1,* $\Delta p_x.\Gamma_G = h$. In other words, if the path-limit Γ_G is the half a wavelength of a cell, Δp_x can be regarded as momentum in that cell in a direction, e.g. *x*-axis. Thus, Δp_x is related to momentum of an expandon in *x*-direction during its emission. According to above discussion, we can reach to a quantization of gravitational field from viewpoint of *HPPH*. The cells geometrical arrangement in spatial medium, *Sec. 7(4)3, part A*, analogous to *Fig. 5(8)* can be constructed based on *GRT*. According to above discussion, and referring to *Sec. 2(4)2a*. It is proposed that, the law of gravitation field from viewpoint of *HPPH*, is compiling on the basis of H hall package (or cell, i.e. a slice of spatial space-time) in a cone-like cavity, *Sec. 5(2)1d, part D*, as in *Fig. 5(8).* In other words, the main cell transfers (or better to says expands) to adjacent cells or upper cells radially and tangentially respectively in the cavity during stay time intervals ΔT_G along with decrement of ΔE_G in upper gravitational spheres, and increments of path-length limit Γ_G. Please refer also to *Sec. 5(16)1b, part A, item 29,* and *Note 5(16)1b, G1a*. Factually, the decrement of energy ΔE_G, is performed up to reach to ΔE_d in gravity free vacuum. Moreover, ΔT_G, Γ_G are increased up to ΔT_d, Γ_d i.e. stay time interval, and path-length-limit in gravity free vacuum medium respectively. Noteworthy, the behavior of an expandon in a cone-like cavity is analogous to particle trapped in a potential well (one-dimensional motion), *Sec. 8(2)1*. It is due to non-aberrative characteristic of gravitational field, *Sec. 5(2)1d, part B*, that is considered as a solid cone-like cavities H system. Moreover, based on *Sec. 2(6)2a, item C*, the stay time interval Δt is the universal quantized time unit ΔT_Γ of a main cell in any location of gravitational sphere in spatial medium. It can be defined as unit of times $T_1, T_2, T_3, \ldots$, *Sec. 5(16)1b, part A, item 2III,* on gravitational spheres *1, 2, 3, ...* Please refer also to *Note 2(3)2b1*.

Resuming, according to above discussion, and comparing the geodesics in *GRT* with *CF*-lines, *Sec. 5(2)1a,* in *HPPH,* one can have a view of expandon emission on points (or locations) of *CF*-lines based on Huygens principle, *Note 5(2)1e*, by analogy to the light. In other words, any main cell on a *CF*-line (or space-time geodesic) emits sub-expandons on newly formed sub-cells, thus constructing new *CF*-lines again up to expandons reach to infinity or better to say to gravity free vacuum energy. These sources are located in Γ_G intervals of each other's in related location on *CF*-lines, and obeying the *Eq. 7(5)1*. In fact, the geodesics (or *CF*-lines) are on the direction of H hall package tunnels that connect the related cells with each other's. Moreover, the released contractons during emission by a cell are transferred via these tunnels towards mass medium, *Sec. 7(4)3, part D*, of e.g. mass-body *M* of *Fig. 5(8)*. Factually, based on *Sec. 5(9)3d, part c*, there is a mutual contractons exchange between related expandon and mass-body *M* via these tunnels. In other words, through contracton releasing by expandon towards mass *M*, and vice versa, there is an expandon radially forward transfer to upper level and backward transfer radially with slight preference of the former, i.e. an attraction analogous to particle in *Sec. 9(4)7, Fig. 9(3)a*, during stay time interval ΔT, *Sec. 7(4)2f, part A*. In other words, a particle jiggles in spatial medum, *Simulation 8(7)2, E5a, item 23,* about its rest state. During this process, a sub-expandon or sub-cell is generated by the main expandon cell. According to above discussion, this is **why?** the secondary waves traveled only in the <u>forward</u> direction, *Note 5(2)1e1*, based on Huygens principle.

Note 5(16)1b, G1a- Based on *Simulation 8(7)2, E5a, item13,* a gravitational sphere of mass-body *M*, e.g. number n th, that is constituted of n_s main cells as in *Fig. 5(8)* becomes unstable and decayed to next upper level, i.e. number $n+1$; i.e. when, the aggregated contractons are is reached to its critical value ΔT_{crit}. Thus, according to *Eq. 8(8)b*, we have:

$$\Delta T_{crit} = n_s \Delta T_{Gn} \qquad 5(67)4d$$

Where:

- ΔT_{crit}, can be considered as time intervals between two successive gravitational spheres $n, n+1$
- ΔT_{Gn}, is stay time interval of an expandon main cell on gravitational sphere n

G2) Wave function of expandon

"Consider the Schrödinger (time independent) wave equation

$$-\frac{\hbar^2}{2m}\nabla^2\psi + U\psi = E\psi \qquad 5(67)4e$$

Which is expanded as

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)\psi + \frac{2m}{\hbar^2}(E-U)\psi = 0 \qquad 5(67)4f$$

In Cartesian coordinates" [636] for hydrogen-like atoms. By analogy of gravity and electromagnetism, *Sec. 5(16)1d*, and according to *Eq. 5(3)* of *Sec. 5(1)1*, and assuming $m = m_s$ the mass equivalent of an expandon at the moment of its emission on gravitational ground potential sphere of mass equivalent dM based on *Note 5(1)1b*, we have:

$$m_s = \frac{dM}{n_s} \qquad 5(67)4g$$

Where:

- dM , mass equivalent related to a gravitational sphere related to mass *M*.
- n_s , the total number of Planck area each related to a group of N_0 H particle-paths on a potential gravitational sphere of mass-body *M*.
- m_s , the mass equivalent of an initial emitted expandon on potential ground sphere.
- E, U , the total and potential energies of the mass m_s respectively

Therefore, according to above discussion, by applying the Schrödinger equation, *Eqs. 5(67)4e, f,* to an expandon we have:

$$-\frac{\hbar^2}{2m}\nabla^2\psi - G\frac{Mm}{r}\psi = E\psi \qquad 5(67)4h$$

Thus, considering the distance r from expandon to center of mass *M* is great enough, one can omit the second member of left-hand side of *Eq. 5(67)4g* as following:

$$-\frac{\hbar^2}{2m}\nabla^2\psi = E\psi \qquad 5(67)4i$$

According to *Eq. 2(33)* of *Sec. 2(1)3,* the *Eq. 5(67)4h* can be written as follows:

$$-\frac{\hbar^2}{2N_0 H}c^2\nabla^2\psi = E\psi \qquad 5(67)4j$$

Where:

-*H,* the energy equivalent related to an H particle-path.

Thus, by analogy to *Sec. 9(4)7* for a particle, a wave function can be established for an expandon in a gravitational field of mass-body *M*.

5(16)1c- Discussion

A- General aspect

A1- Non-accelerating state

Any n_G collection of H particle-paths of equivalent mass dM related to energy of gravitational field, *Sec. 5(1)1, Note 5(1), Eqs. 5(1), 5(7),* that moving tangentially at reversible motion and expanding at single direction radially constitutes an expanding gravitational closed surface (or sphere), *Sec. 5(16)1b, part A, paragraphs 3*; therefore, the whole velocity of each of its H particle-paths is equal to c, *Sec. 5(16)1b, part A, paragraph 4.* According to *Sec. 2(10)1,* the forwarding, ΔT_F and backwarding ΔT_B, and average, *Sec. 5(16)7a,* ΔT_{FB} , time's arrows of gravitational field due to H particle-paths of *Fig. 5(8)* obeys the *Eqs. 2(116)-(118*). In other words, time's arrow generation is along with space expansion during path-length, *Sec. 2(1)2,* generation (or better to say quantized H hall quantized packages, *Sec. 5(16)3a,* splitting); please refer also to *Sec. 5(16)1b, part E*. On other hand, ΔT_r and ΔT_t , *Sec. 5(16)1b, part A, paragraph 3*, depend on partial time's arrow, *Sec. 7(4),* related to gravitational spheres, *Remark 5(16)1c, A1*.

According to above discussion, the time arrow generation (e.g., ΔT_{12}) due to two successive expanding spheres transition (e.g., sphere *1* to *2* at time T_1, T_2 , respectively), *Sec. 5(16)1b, part A, Eq. 5(63),* is proportional to the difference of related average partial time's intervals, i.e. ΔT_{1FB} , ΔT_{2FB} , during related gravitational sphere expansion. Thus, according to *Sec. 5(1), Eq. 5(7),* and *Sec. 5(16)1, Eq. 5(51),* we have:

$$\Delta T_{12} = T_1 - T_2 = n_s\left(\Delta T_{1FB} - \Delta T_{2FB}\right) = K_G.n_G\left(\Delta T_{1FB} - \Delta T_{2FB}\right) =$$

$$K_G.n_G.\Delta T_{12FB} = \frac{dr}{H_o r} = \frac{8\pi^2 G}{H_o c^3}\left(\frac{a_s}{b}\right) = Constant \quad (second) \qquad 5(67)5$$

We have supposed that the mass *M* main body is constituted of N_0 H particle-paths moving at c speed and related average partial time, $\Delta T_{FB(mass)}$, *Eq. 2(119);* therefore, according to *Eq. 5(67)5*; *Sec. 2(10), Eqs. 2(116)-(118), Consequence 2(10)1c*, and considering mass and field at an equilibrium state and referring to *Sec. 5(5)1, Eq. 5(1)1*, and *Sec. 5(16)1a, Eq. 5(51),* we have:

$$a_1^{-1}\,K_m = N_0.\Delta T_{FB(mass)} = K_G\,n_G.\Delta T_{FB(field)} = N_0 K_\Gamma K_G \Delta T_{FB(field)} = A K_\Gamma H_0^{-1} =$$

$$d\tau = \frac{8\pi^2 G}{H_o c^3}\left(\frac{a_s}{b}\right) = 2A\left\|\hbar\right\| H_o^{-1} = 2A\hbar\left(\frac{bu^2}{a_s}\right) H_0^{-1} = 2A\,\hbar\, S_u^{-1} H_o^{-1} = 0.85\times 10^{-16}\ (s) = Constant \qquad 5(67)6$$

1

Please refer to *Consequence 5(16)1b, A3; Comment 5(16)1c, A1; Remarks 5(16)1c, A2, A3; Proposal 5(16)1c, A1, A2,* and *part A3*. Moreover, please refer to *Sec. 7(4)2e* in case of particles.

Assuming, $K_m \cong 1$, *Remark 5(16)1c, A4,* in case of a fundamental particle, according to *Eq. 5(67)6* and $d\tau$ value, *Sec. 5(16)1a, Eq. 5(51),* we have:

$a_1 \approx (d\tau)^{-1} = 1.177 \times 10^{16} = a\ dimensionless\ constant$ 5(67)7

Please refer to *Sec. 2(4), Remark 2(4)3; Sec. 2(10)1, Remark 2(10)1b; Sec. 5(16)2a;* and *Sec. 7(4).*
Where:

- S_u, action unit, i.e. $S_u = 1b^{-1}u^{-2}a_s$; please refer also to *Sec. 2(4).*
- *A*, Correction factor, *A= 0.9262.*
- H_o^{-1} is the age of Universe, *Sec. 5(16)1a, Remark 5(16)1a2.*
- a_1, constant of media coefficient, *Note 1(2)1.*
- $a_s = 1s^{-1}$, *Note 1(2)1,* $b = 1kg^{-1}, u = 1m^{-1}$ of inverse dimensions based on units of dimensions in *SI* units.
- $\Delta T_{FB(mass)}$, is the partial average time's arrow interval, *Sec. 2(10)1, Eq. 2(119),* related to handedness reversal, *Sec. 5(16)9b.*
- $\Delta T_{FB(field)}$, the partial time's arrow reversal interval between two successive cells on ground gravitational sphere and is equal to ΔT_{12FB} in the above example as a constant value, *Comment 5(16)1c, A1.*
- $d\tau$ - It is equal to $n_G.\Delta T_{FB(field)}$, i.e. Total time's arrow related to an expandon on Schwarzschild horizon of the mass, *Sec. 5(16)2*, and *Comment 5(16)1c, A1.*
- dr, is: the difference between two successive spheres *1 & 2* at radii r and $r+dr$, please refer to *Sec. 5(17).*
- ΔT_{1FB}, ΔT_{2FB}, ΔT_{12FB}, are time's arrows related to gravitational spheres *1&2*, and their related constant difference respectively.
- n_s, total number of H particle-paths on a potential gravitational sphere.
- K_m, a dimensionless constant.

Noteworthy, the left-handedness of fermions depends on the time's arrow reversal as in $\Delta T_{FB(mass)}$. Whereas, the right-handed space expansion related to time's arrow as in $\Delta T_{FB(field)}$, *Consequence 5(16)1c, A1*; please refer to *Sec. 5(16)5*.
A mass-body regardless of its mass magnitude, e.g., The Sun, the Earth, can be considered as a unique H system, *Sec. 8(5),* and its unique related H hall quantized package, *Sec. 5(16)3a;* moreover, *Eq. 5(67)6,* similarly to *Eqs. 2(116)-(118)*, can be regarded as a result of path-length constancy, *Sec. 2(1)2*; please refer to *Consequence 5(16)1c, A2.*
In fact, expanding gravitational spheres according to *Eq. 5(67)6,* are responsible to path-length generation, or, in other words, time's arrow and space expansion; therefore, without gravitational concept as above, the time is meaningless, i.e. $\Delta T_{FB(mass)} \to 0$, due to lack of, time interval $\Delta T_{FB(field)}$, *Consequence 5(16)1c, A3*. In other words, supposing the expansion is stopped suddenly, *Sec. 5(16)9c,* the clock time will be stopped accordingly. By a far simulating example, supposing a group of runners running successively in a straight–line at equal distances; suddenly the first one is stopped, therefore the others will be crashed to the first one. By referring to this example, the H particle-paths of the mass will be crashed. Furthermore, according to *Sec. 5(7),* the pre Big Bang without concept of gravitational field is meaningless, i.e. zero ΔT_{FB} time's arrow, *Note 5(16)1c, A1*; please refer also to *Sec. 5(16)9c, part B*.
The above discussion is related to the mass-body at non accelerating state; therefore, the time's arrow related to each surface of constant gravitational potential value, i.e. equipotential spheres, is the same, and decrease radially with increase of sphere radius r, *Sec. 5(16)1b, part A*, *paragraph 3*. The time's arrow on each of equipotential sphere is compatible with scalar one, *Sec. 2(1)1b, Consequence 2(1)1b1*, *part c, case I.*

Proposal 5(16)1c, A1– The *Eq. 5(67)6* is proposed to be written according to the following manner:

$$K_m' = a_1 d\tau' = \frac{8\pi^2 (G A^{-1})}{H_o c^3}\left(\frac{a_s}{b}\right) = \frac{8\pi^2 G'}{H_o c^3} = 2\hbar S_u^{-1} H_o^{-1} \qquad 5(67)8$$

Where, $G' = A^{-1}G$, $K_m' = A^{-1}K_m$, $d\tau' = A^{-1}d\tau$, *Comment 5(16)1c, A2;* please refer also to *Sec. 5(16)4, Eq. 5(70)7(1).*
$G', K_m', d\tau'$, the modification of *G*, K_m, $d\tau$ respectively, in case of small isolated mass-bodies (far enough from external gravitational field, *Note 5(16)1c, A1*). In other words, in a pure vacuum space medium, i.e. background time arrow dominate, *Sec. 5(16)1c, part c*. Alternately, in the cases of experiment that leading to $\hbar$ determination (or dealing with that) we are encountered with negative particles that cover the gravitational effect and making it negligible. According to *Eq. 5(67)8*, *G'* (or *G*) depends on three fundamental constants, $\hbar, c, H_0$. Noteworthy, the two former ones are regarded as immutable constants of nature; whereas, the latter one is depended on the magnitude of *G* at a location of a medium.

Proposal 5(16)1c, A2- The time interval $d\tau$ is the time's arrow generation during a gravitational sphere emission, *Sec. 7(5)3d, part D*, on the mass-body Schwarzschild surface. It must not be confused with time interval between two successive gravitational spheres. Factually in case of particles, K_m and n_s is equal to one, *Remark 5(16)1c, A4*. Thus, $\Delta T_{FB(field)}$ is coinciding with stay time of the particle, *Sec. 7(4)2f, part A*, or, in other words, the time interval between $WR\ \&\ WL$ expandons (or its *Simulation 7(4)2e1,* (or equivalent to time interval between two successive gravitational spheres of particles). In case of macro mass-body $n_s > 1$, and $\Delta T_{FB(field)}$ can be equivalent to time interval between two successive gravitational spheres emission on the

Schwarzschild surface. According to *Sec. 5(6)1, item II,* $\Delta T_{FB(field)}=\upsilon_0^{-1}$, where, υ_0 is the frequency of standing de Broglie matter wave of a mass-body at rest state, *Sec. 2(4)4b,* i.e. equivalent time interval between two successive gravitational spheres emission on Schwarzschild surface of the mass-body.

Consequence 5(16)1c, A1– A time's arrow is accompanied by its reversal by slight preference of the former according to bi-Universe hypothesis, *Sec. 5(16)9*. Therefore, the actual time's arrow is the algebraic sum of time's arrow and its reversal.

Consequence 5(16)1c, A2- According to *Eq. 5(67)6,* total time's arrow of an isolated:

1) Mass-body is independent of its mass magnitude at each constant time interval, $d\tau$ *, Sec. 5(16)1a, Eq. 5(51);*and at this section *, part A1, Eq. 5(67)6.*

2) Mass-body field is equal to that of main mass-body at each constant time interval, i.e. $d\tau$.

3) Mass-body is supposed to be divided equally to n isolated (or none correlated) parts; therefore, the total time's arrow of n H system is multiplied by n, i.e. $nd\tau$ or, in other words, the entropy of the whole system is increased by n time, and vice versa.

Consequence 5(16)1c, A3– According to this discussion the present time is true time. "Have past objects, such as dinosaurs, slipped out of existence? Philosophers are divided into tree camps on this question, and more generally, on the question of the reality of the past and future. The presentist viewpoint maintains that the past and the future are not real, and that only the present is real, so if a statement about the past is true, this is because some present facts make it true" [434] *part 9*. Is only the present real?. According to H particle-paths hypothesis, the time's arrow reveals merely during the process of present expansion of the Universe at each local of space. Noteworthy, the human being at this location can be regarded as an observer and component at this location.

Note 5(16)1c, A1:

A) According to *Sec. 5(7)1, Sec. 5(8)1, Eq. 5(34)2*, the Newtonian constant of gravitation *G* depends inversely to Planck time square that may be related somehow to internal time arrow, $\Delta T_{FB(mass)}$; thus, to $\Delta T_{FB(field)}$ of the mass-bodies. The latter finally leads to background time arrow at infinity (or long distance). According to *Proposal 5(16)1c1*, the Newtonian constant of gravitation leads to *G'* at background time arrow dominate medium.

B) Alternately, referring to discussion held in *Sec. 2(4)4a*, and considering the reduced Planck constant $\hbar$, the light speed c as immutable constants. Now, supposing the gravitational constant G at the present time is related by correction factor A to gravitational constant G' at the Big Bang era, i.e. $A=1$. Therefore, the correction factor A depends somehow to the degree of left-handedness (or handedness) increment since the Big Bang era, *Note 7(4)3, j1*. As a result, the gravitational constant G is decreasing, *Sec. 5(16)2a*, in such a manner that the product $A^{-1}.G$ remained constant during the evolution of the Universe up to a finite maximum entropy, *Comment 5(15)3b1*. The dimensionless factor K_G , *Eq. 5(1)1*, is equal to correction factor A . It is assumed to be equal to one for reason of simplicity in right-hand side of *Eq. 5(5)*; please refer also to *Sec. 2(4)4a*. Factually, according to *Sec. 5(1)1, Eq. 5(5)*, the gravitational constant G depends on N_G , the equivalent number of interacting neutropa in a potential sphere per mass unit. Therefore, N_G depends on the mass of SM configuration to SN_r and SP_l one, N_G is decreasing accordingly. Thus, G (or N_G) depends somehow via correction factor A to D_h , the handedness degree that had the maximum value at the big bang era.

Comment 5(16)1c, A1- By some analogies, the maximum total time's arrow interval $d\tau_G$ of an expandon, can be compared to the maximum time's arrow ΔT_Γ (or $d\tau_d = a_d^{-1} = a_1^{-1}$, *Sec. 7(4)3, part H*) of an isolated particle in a gravitational field free vacuum medium. Therefore, according to *Eq. 5(67)6,* $d\tau_G$, $d\tau_d$ are linked to each other through following relationship:

$$d\tau_G = a_1^{-1}.\frac{K_m}{K_G.n_G} = a_G^{-1}.\frac{K_m}{K_G} \quad \text{, Note 1(2)1, case A(II)} \qquad 5(67)8a$$

According to *Consequence 2(10)1b*, and *Sec. 5(1)1, Eq. 5(1)1*:

$$K_m = n_s = K_G.n_G = A.n_G \qquad 5(67)8a1$$

Where:

- n_s , The total number of Planck area each related to a group of H particle-paths on a potential gravitational sphere
- n_G , The total equivalent number of the group of H particle-paths related to the interaction of the gravitational field
- K_G , dimensional constant factor
- A , correction factor A= 0.9262, *Sec. 5(16)1c, part A1*

Therefore, according to *Eq. 5(67)8a*, we have:

$$d\tau_G = \frac{A n_G}{a_1 K_G n_G} = a_1^{-1} = \text{Constant}$$

Referring to *Eqs. 7(31), 7(32)* of *Sec. 7(4)3*, we have:

$a_{mass}\cdot\Gamma_{mass}=a_G\cdot\Gamma_G=a_d\,\Gamma_d=a.\Gamma=c,$ or $\Gamma_G=\frac{a_d}{a_G}\Gamma_d,\quad \Gamma_{mass}=\frac{a_d}{a_{mass}}\Gamma_d$ 5(67)8b

Analogous to *Eq. 5(67)8a*, based on the idea that mass is contracted form of it related gravitation field, and field is expanded form of the mass, *Sec. 2(2)2*, we have:

$d\tau_{mass}=a_{mass}^{-1}$ Per second 5(67)8c

Where:

- a_d, a_G, a_{mass} are the coefficients of inverse dimension through normal vacuum, gravitational field, and mass medium respectively.
- $\Gamma_d,\Gamma_G,\Gamma_{mass}$ are the path-limit in normal free vacuum, gravitational field, and mass media respectively.

Please refer also to *Sec. 7(4)3, parts A, B, D, H.*

Comment 5(16)1c, A2– According to [321], *part 1, Gravity anomalies*, "Note that variation in the experimental values of *G* do not necessarily mean that *G* itself varies; they probably mean that the local manifestation of *G* or the Earth's surface gravity *(g)*, varies according to ambient conditions".

Remark 5(16)1c, A1- The clock rate (or clock time) in an H system depends on the rate (or acceleration) of time's arrow generation, *Sec. 5(16)7a,* and or better to say, to the path-length generation mainly in the course of gravitational sphere (or closed surface) expansion, *Sec. 5(4).* In fact, the time or better to say time's arrow, *Sec. 5(16)7a*, is an entity that can be accessible only during expansion process and its quantity depends on expansion rate, i.e. more expansion rate more time rate slowness, i.e. clock march slow. Mass can be regarded as a store of path-length (or time's arrow and related space generation); moreover, according to which, the time's arrow generated during mass conversion to its expanded form, i.e. gravitational spheres, *Note 2(1)3b,* can considered as clock rate. Similarly, by a loose example it can be compared to the fuel tank in a car and the rate of its consumption accordingly; by the difference that in the former case we cannot alter the clock rate as an intrinsic phenomenon of the nature. By the way, the time rate in case of a mass m, e.g., satellite, in gravitational field of another mass *M*, e.g., The Earth, is the result of interaction of H particle-paths of the latter gravitational field with that of the former main body, or, vice versa. It depends on the field H particle-paths' density of mass *M* field, or, in other words, to their related distance; please refer to *Sec. 5(16)2c*.

Remark 5(16)1c, A2- The relationship *Eq. 5(67)6* is based on path-length at equal magnitude of opposite sign, *Comment 5(2)1c1,* in both of vacuum and mass media, *Sec. 7(4)3*. In other words, the path-length in vacuum medium has right-handed characteristic, e.g. positive sign; whereas, the path-length through mass medium has left-handed characteristic, e.g. negative sign, considering bi-Universe hypothesis, *Sec. 5(16)9a*. Therefore, the algebraic sum of two path-lengths, i.e. path-length variation, is zero due to Mirror Image Effect, *Sec. 5(2)3*.

Remark 5(16)1c, A3– Multiplying the both side of *Eq. 5(67)5*, [or *Eq. 5(67)6*] by h and referring to *Sec. 5(8)1, Eq. 5(33),* and *Sec. 2(10), Eq. 2(117),* we Have:

$N_0 a_1 h\Delta T_{FB(mass)}=n_s a_1 h\Delta T_{FB(field)}=K_G n_G a_1 h\Delta T_{FB(field)}=h K_m$ or 5(67)11a

According to *Sec. 5(1)1, Eq. 5(1),* $n_s ah=E_s$, $n_G ah=E_G$ and *Sec. 2(1)3, Eqs. 2(33), to 2(35),* $N_0 a_1 h=E_o$, and referring to *Sec. 5(16)1a, Eq. 5(55)2,* the *Eq. 5(67)11* is converted to:

$E_0.\Delta T_{FB(mass)}=E_s.\Delta T_{FB(field)}=K_G E_G.\Delta T_{FB(field)}=K_m h$ 5(67)11b

Referring to *Sec. 5(7)1, Sec. 5(8)1, Eq. 5(33),* we have:

$$E_G.\Delta T_{FB(field)}=(K_m K_G^{-1})h=\frac{A}{\pi}a_1 h^2 H_o^{-1}K_G^{-1}(S_u^{-1})=16\pi^3 a_1 l_p^2 K_G^{-1}H_o^{-1}\left(\frac{a_s}{b}\right)$$ 5(67)12

Please refer to *Sec. 5(16)1a, Remark 5(16)1a3*

Where:

l_p^2, is the Planck area, *2, Sec. 5(8)1.*

K_m, is a dimensionless constant; and, it is equal to one (or more than one) in case of a free moving fundamental particles; please refer to *Sec. 2(10)1, Eq. 2(117),* and *Sec. 7(4).*

$\Delta T_{FB(field)}$, is the time interval between to successive gravitational expanding spheres, e.g., spheres *1, 2*.

Therefore, assuming h as immutable constant the left side of *Eq. 5(67)12* increases as H_o^{-1}, i.e. the age of the Universe increases accordingly. Moreover, the Expandon obeys the relation ship *Eq. 5(67)12* which differs from the case of ordinary particle (or mass-body), *Eq. 5(67)11b*, by second order of magnitude of Plank constant and inverse of Hubble constant. In other words, it is also restricted by Plank area, l_p^2, *Sec. 5(7)1, Sec. 5(8)1, Eq. 5(33).*

Remark 5(16)1c, A4- According to *Sec. 2(10)1,* and *Sec. 5(2)1d, part D*, in case of a particle $K_m\cong 1$. In other words, n_s (or n_G) is equal to unity. Therefore, K_m in *Eq. 5(67)6*, in case of macro-bodies is proportional to n_s (or n_G).

A 2 – Accelerated state

Supposing during a collision, *Sec. 6(2)1a*, or, external force applying, *Sec. 6(2)1b*, according to *Sec. 6(2)3; Sec. 5(16)2a*, there is a single direction linear contraction in the same direction of external effect toward the singularity zone, i.e. Schwarzschild sphere. Therefore, $\Delta T_{FB(mass)}$, *Eq. 5(67)6* is affected according to *Sec. 2(10)1*. Thus, the $\Delta T_{FB(field)}$, *Eq. 5(67)6*, is affected accordingly. In other words, we have beside the time's arrow of *part As!,* a mono-dimensional time's arrow comparable with *Sec. 2(1)1b*, *Consequence 2(1)1b1*, *part c, case II*, in the direction of applying force related to *SN* configuration*, Sec. 3(1)2, Fig. 3(4)b*, mode of motion. Therefore, a time's arrow reversal at the same magnitude related to *SP* configuration , *Fig. 3(4)a*, in the opposite direction of the latter one that are established during acceleration due to Mirror Image Effect, *Sec. 6(2)3*. By the way, their magnitudes vary proportional to the magnitude of acceleration. Please refer to *Sec. 5(16)1b, part A, paragraph 15* for complementary information.

As a result, the back to back equilibrium between matter and antimatter Universes, *Sec. 5(16)9*, (with the preference of the former one) is broken at a short time period of interaction due to single direction acceleration; therefore, an anisotropy through the gravitational field of the mass-body in the co-direction and counter-direction of this acceleration is revealed accordingly. Resuming, the quantized texture fabric of the gravitational field of accelerating mass-body can be analyzed as superimposition of that of *part A1* of *SN* configuration preference, *Sec. 5(16)1b, part A, paragraphs 15, 16; Sec. 3(1)2, Fig. 3(5)b.* In addition, induced *SN & SP* configurations, *Figs. 3(4)a, b,* at equal magnitude in co- and counter-direction of accelerating mass-body respectively. Please refer to *Sec. 5(16)3d*, *Remark 5(16)3d1*, in this respect. Noteworthy, the *SP* and *SN* configurations cited above are related to the field; whereas, according to Mirror Image Effect the configuration of the mass is reverse handedness of the related field, or, in other words field of *SN* configuration related to mass of *SP* configuration and vice versa, , *Sec. 5(16)1c, part A1*.

A3 – Expandon and graviton

According to *Sec. 5(16)1a, Remark 5(16)1a3,* the *Eq. 5(67)5* will be:

$$n_G.\Delta T_{12FB} = 2A\hbar H_o^{-1}\left(\frac{bu^2}{a_s}\right) \quad (s) \qquad \text{or} \qquad 5(67)9$$

$$n_G.\Delta T_{12FB}.A^{-1}H_o S_u = 2\hbar \qquad 5(67)10$$

Where:

- a_1, constant of media coefficient, *Note 1(2)1*.
- $a_s = 1s^{-1}$, *Note 1(2)1,* $b = 1kg^{-1}, u = 1m^{-1}$ of inverse dimensions based on units of dimensions in *SI* units.
- S_u, action unit, i.e. $S_u = 1b^{-1}u^{-2}a_s$; please refer also to *Sec. 2(4).*
- H_o - Hubble constants and its inverse is the age of the Universe, *Sec. 5(16)1a, Remark 5(16)1a3*.
- $\hbar$ - *h-bar* (*h* is the Planck constant and $2\hbar$ value is equal to the spin of a hypothetical particle, e.g., graviton.
- K_G - The dimensionless factor, *Sec. 5(1)1, Eq. 5(1)1; Sec. 5(16)1c, part A1*, *A4*, *Eqs. 5(67)7, 8*.

The *Eq. 5(67)10* can be regarded as spin two [or better to say path-length, *Sec. 2(1)2*], *Sec. 5(16)1a, Eq. 5(49)1*. Thus, a long-range acting particle consisting of n_G correlated H particle-paths (that is expanding on gravitational sphere with the description as stated above, i.e. massless, spin *2*) is expanding up to the whole Universe. It obeys the *Eqs. 5(67)5,* with total energy equivalent to mass *dM*, *Sec. 5(1)1, Note 5(1)2, Sec. 5(16)1a, Eq. 5(49),* (nominated expandon, *Sec. 5(16)1c, part A3*), and is comparable to hypothetical particle graviton, *Comment 5(16)1c, A4*; please refer to *Sec. 5(16)1a*, *Example 5(16)1a1*. Moreover, expandon of spin of conventional path-length value $+2\hbar$, *Sec. 5(16)1a, Eq. 5(49)1*, according to Mirror Image Effect, *Sec. 6(2)3,* has a correlated, *Secs. 8(7), 8(9),* left-handed spin conjugate of $-2\hbar$ value, i.e. contracton, *Sec. 5(2)1c, part c*. Similarly, in case of expanding closed surface (or sphere) as in *Sec. 4(6)1,* the former is called negaton (or Positon) depending on its source of its negative (or positive) charge, *Sec. 4(6)4.* Negatons are constituted of right-handed negapas and positon of left-hand posipas. Negaton and positon are expanding on potential spheres due to negatively charged free particles (e.g. electron) and positively charged free particle (e.g., nucleons) respectively. Therefore, in the cases of engaged charged particles (e.g., atoms) right-handed expandons of SN_r are generated on the Schwarzschild surfaces, *Sec. 5(16)2a*, that differs from separate interaction of negatons and positons as in *Sec. 4(3)1, Fig. 4(5),* of free moving charged particles in the vacuum space. According to the above statements, expandons have different amount of energies, *Note 5(16)1c, A3*, but with identical spin $2\hbar$ that expand preferably right-handedly, *Sec. 5(16)5, Remark 5(16)5a,* in our matter Universe nominating *WR* expandon. Thus, it is analogous to photon with different energy and spin $1\hbar$; whereas, the latter is an open-end H system contrary to former that is a closed H system, *Comment 5(16)1c, A4, part 2*. Please refer also to *Comment 5(2)1c1*.

Expandons during its generation on the surface, S_S, of radius of Schwarzschild, l_S, has a path-length value $2\hbar$, *Sec. 5(16)3g*. Similarly, to an H system, e.g., photon, *Sec. 7(2), Comment 7(2)1a*, it has a hidden (or stored) path-length of $2n_G\hbar$ value. In other words, expandon can be regarded as n_G cells each of stored path-length value $2\hbar$, *Comment 5(16)1c, A3*, or gravitational sphere. Please refer also to *Sec. 7(4)1, paragraph 3*. The effect of n_G stored cells can be revealed as entropy on Schwarzschild sphere, e.g., black hole entropy, *Sec. 5(7)1, Sec. 5(7)6*. Moreover, according to *Sec. 5(16)11*, a *WR* expandon has an expanding right-handedly type R_e path-length; whereas, its contracton conjugate has a left-handedly contracting type L_c path-length of equal magnitude and opposite sign. Note that, each expandon on front of its *CF*-line and normal to that front (curvature) emits contracton towards the center of mass of related interacting mass-body *Proposal 5(2)1a1*. It is due to expandon of interacting mass-body field with the mass medium, *Sec. 7(4)3, part D,* of interacted mass-body, *Sec. 5(2).*

The expandons have different kinds as following:

1) Gravitational expandon (*G*-expandon) that is propagating in spatial medium, *Sec. 7(4)3, part A*. It has two types *WR & WL* related to types *R & L* configuration, *Simulation 7(4)2e1,* with slight preference of the former in our matter Universe.
2) Compactified expandon, *Sec. 6(2)6b, part B*, related to interaction as e.g. collision, measurement.
3) Electromagnetical expandon (or *E*-Expandon), *Sec. 4(3)1, part C*. Its effect is similar to gravitational one in *item 1*. The *E*-expandon has two types nominating negaton & positon, *Sec. 4(6)4*, that acts as singlet, *Note 4(1)1*, without accompanying other expandon singlet related to opposite sign charge. Moreover, according to *Simulation 7(4)2e1,* and *Sec. 4(4), Fig. 4(8),* The *WR & WL* expandons are equivalent to negaton & positon respectively.

Note 5(16)1c, A3- According to *Sec. 5(16)1c, A2*, *Eq. 5(67)12*, the total energy attributed to an expandon is E_G that is related to n_G (or n_s) H particle-paths in a gravitational expanding surface.

Comment 5(16)1c, A3- Factually, any cell (or a group of that up to n_G correlated ones) that contributes (or reveals) its stored path-length just during an interaction (or measurement, *Sec. 8(7)2*) in H hall package, *Sec. 5(16)3a*, of path-length value $2\hbar$ can be regarded as an expandon, *Sec. 2(4)4a*. "Sundrum proposed that the graviton is a fat object with a *size about* R_{vac} and has been exploring how this might reduce its coupling to the vacuum energy, although it is not yet clear how self-consistent this is" [470] theoretical speculations. According to *Note 7(4)3, A1*of *Sec. 7(4)3a, parts B, H,* and the path-limit Γ_d
Through an H hall package is analogous to length scale R_{vac} based on above statement.

Comment 5(16)1c, A4:
1) According to [296] "The graviton is exchange particle for the gravity force. Although it has not been directly observed, a number of its properties can be implied from the nature of the force. Since gravity is an ***inverse*** square force of apparently infinite range, it can be implied that the rest mass of the graviton is zero". "If it exists, the graviton must be massless (become the gravitational force has unlimited range) and must have a spin of *2* (become gravity is a second-rank tensor field [297]", *preface*. "A graviton in perturbative string theory is a *closed string* in a very particular low-energy state", "An interesting feature of gravitons in string theory is that, as closed strings without endpoints, they would not be bound to branes and could not bound to branes and could move freely between them". Gravitons, the particles of the gravitational force, are viewed as *closed strings*, and are able to slip off our brane–world, which explains why the gravitational force is so much weaker than the other forces that hold matter together, [348], *page 11*. The closed strings according to string theory is analogous to some extent to the gravitational expanding spheres of a mass-body according to H particle-paths viewpoints, *Sec. 5(4)1; Sec. 5(16)1b*.
"The graviton theories of gravity are not ridiculed. However, these appear to explicitly contradict general relativity. This is because gravitons would create a real force instead of fictitious one. According to *GR*, no force is tolerable, if it really is warping of space" [407]. Please refer also to *Sec. 8(8)2, item 9*.
2) "Arkani-Hamed, Demopoulos and Dvali proposed that the true Planck mass could be as low as 1Tev: in their scenario all the standard model particle are represented by open string whose ends are fixed to 3+1 dimensional brane. While, the graviton which is represented by a closed loop of string is free to propagate in the 10+1 dimensional bulk"[470] *large extra dimensions*.

Comment 5(16)1b, Aa- In case of continuity of spatial medium, traditionally according to ketab-e-sharrif: "Do they not then look up to heaven (sky) above them how we have made it and adorned it and ***it has no gaps***"[110]A, *Surah 50, verse 6*.

A4- Gravitational time unit

In the integration (or differentiation) respect to time one can use quantized non splitable time unit, $d\tau$ (or integral unit of that) instead of dt the arbitrary infinitesimal time variation (or interval), since the gravitational effect has main contribution in time's arrow respect to other ones; please refer to *Sec. 5(16)7c*. Moreover, according to *Sec. 5(16)1c, Eq. 5(67)6,* the ratio of the age of Universe, $T = H_o^{-1}$ to $dt = d\tau$ is equal to:

$$\frac{T}{dt} = \left(2A\left\|\hbar\right\|\right)^{-1} = \frac{(S_u)}{2A\hbar} = 0.512\times10^{34} \qquad 5(67)12a$$

The time interval $d\tau$, *part A1, Eq. 5(67)6*, can be regarded as a universal time unit and according to the latter:

$$d\tau = \frac{K_m}{a_1} = 0.85\times10^{-16}\,s \text{ Seconds in } SI \text{ unit} \qquad 5(67)12b$$

Please refer also to *Sec. 7(4)3, part H.*
The quantity $ad\tau$, *Eq. 5(67)12b* can regarded as asymmetry parameter, i.e. a degree of preference of matter over antimatter, but it differs from asymmetry parameter η by six order smaller. According to [212], *A naïve estimation of the baryon asymmetry of the Universe*, "Observational results yield that η is approximately equal to 10^{-10} -more precisely, $2.6 < \eta < 6.2$". This discrepancy may be raised from different concepts of existence matter and antimatter as stated in *Sec. 5(16)9c* according to H particle-paths hypothesis viewpoint. It differs from the idea that state 'asymmetry is due to residual of matter after annihilation of primordial matter and antimatter'.

B) - Limiting conditions

The velocity components of any H system with no rest mass constituted solely of single direction H particle-paths are equal to c (e.g. photon), contrary to particle with rest mass moving at v speed ($c>v$); thus, the time reversal in the direction of these components according to *Sec. 2(1)1b, Consequence 2(1)1b1, case3C* follows the, *Eqs. 2(116)-2(118),* in the former without γ^{-1} contraction factor, *Sec. 2(6)5b*; please refer to *Sec. 2(1)1b, Eq. 2(15)* or *Eq. 2(16),* in the latter case. Therefore, according to *Sec. 5(16)1b, part A, paragraph 3,* we encountered with two time components tangentially (reversible) as ΔT_t, and radially (single direction), *Sec. 2(3), Note 2(3)3b*, ΔT_r instead of a uniform time in all directions as in, *Sec. 2(1), case A*. At the Euclidean space, (i.e. nil gravitational field), both radially and tangentially time interval (related to gravitational field) become nil. Then, we can accept the time concept as in, *Sec. 3A*, i.e. the same at the three directions or dimensions related to the reversible motions of H particle-paths, as in, *Sec. 2(1)1a, Fig. 2(1)*; please refer also to *Sec. 5(16)1c, part c*. At this case, by increasing the velocity of a body the tangential time interval diminished as in, *Eq. 2(12),* of the special theory of relativity; in return, time related to single direction (radially) arise accordingly in such a way that time of twin will be equal, *Sec. 2(6),* respect to the observers at their reference frames.

Similarly, in Gaussian space at the event zone, the stated above situation is reversed; thus, we have radially (single direction) components; moreover, the tangential one, ΔT_t decreases to its minimum level:

$$\Delta T_{t(\min)} = \frac{l_p}{c} \qquad 5(67)13$$

Thus, at event zone, *Sec. 5(16)2a,* we encountered by none zero time intervals.

The maximum of ΔT_t at the Euclidean space is obtained as:

$$\Delta T_{t(\max)} = \frac{\Gamma}{c} = a^{-1}\,(s) \qquad 5(67)14$$

Where:

l_p, Planck length, *Eq. 5(33).*

- a, Media coefficient, *Note 1(2)1*.

C) - Background time

In fact, in external domain of gravitational field related to a mass-body, i.e. nil gravitational field, we encounter with time external to the gravitational potential, i.e. *Eq. 5(68)2*. This time related to background expanding behavior of H particle-paths moving at c speed and its reversible mode of motion as space and time (path-length, *Sec. 2(1)2*) of vacuum space quantized texture, *Sec. 5(16)3b*, in the whole Universe, *Sec. 5(16)3a, Sec. 5(16)3b*. This time, t_e is due to the expanding characteristic of the stated above texture, i.e. to space expansion along with t_e time's arrow, *Sec. 5(16)7a*. In other words, t_e has its existence during expansion; thus, without that is meaningless. Alternately, this time is attributed to the gravitational field free vacuum spatial expansion, *Comment 5(16)1a, B1*, due to background vacuum energy; *Sec. 5(16)3d*, and its rate is depended on vacuum energy density, *Sec. 5(16)3c*. Therefore, it must be included in the time rate, *Eq. 5(63),* related to gravitational field of a mass-body as a background time; please refer also to *Sec. 2(3), Note 2(3)3b.* According to above discussion, the space vacuum is not empty and can be regarded as a texture of path-lengths, *Sec. 2(1)2,* related to expansion of its H particle-paths. Therefore, it is isotropic at macrocosm scale in the whole Universe, the H particle-paths of which have a common motions related to both expansion and individual motions, *Sec. 1(3),* as in any H system. Please refer also to *Sec. 7(6).* Noteworthy, in an inertial reference frame far enough from effect of gravitational fields, this background time can be considered as its time coordinate.

5(16)1d – Electromagnetism and gravity

"Gravity and electricity are indeed very similar in many ways, but the relation between them is not nearly as straight forward as is suggested by the fact that in classical physics they are both governed by inverse square laws" [461] *Quantum Gravity*. Electromagnetic field, *Sec. 4(6)1*, differs from gravitational field, *Sec. 5(4),* as following:

I) The former is constitute of right- or left-handed spin single direction H particle-paths as singlet; whereas, the latter is constituted of reversible H particle-paths based on counter-currency mode of motion, of SN_r configuration, *Sec. 3(1)2, Comment 3(1)2b*. In other words, we encounter with potential momentum (vector potential, *Sec. 4(6)3*) in case of electromagnetism that is related to non-reversible (or single direction motion of H particle-paths in vacuum medium contrary to gravity, *Comment 5(16)1d1*. Please refer also to *Remark 5(16)1d1.*

II) The gravitational waves, *Sec. 5(16)1b, part B,* propagate radially at decelerated speed, i.e. r^{-1} contrary to electromagnetic wave e.g. photon, *Sec. 4,* moving at c speeds. However, we cannot relate the so-called gravitational wave equation simply by comparison to that of electromagnetic ones and vice versa. Moreover, the gravitational energy propagates based on expansion of closed potential surfaces (i.e. expanding gravitational surface, *Sec. 5(4)*) of moving H particle-paths according to counter-currency mode, *Sec. 3(1)2,* radially at a decelerating speed, *Sec. 5(9).* Nevertheless, the total speed of H particle-paths on gravitational spheres or potential (but radially and tangentially) is the light speed. Moreover, the gravitational force (or interaction) contrary to gravitational sphere is propagated spontaneously through counter-current H particle-paths within H hall package tunneled between interacting mass-bodies, *Sec. 5(2)1d*. As a result, in this case by analogy with gravity, the electromagnetical potential and force propagation behave the same as the former. Furthermore, mass and energy are linked by Einstein's equation $E = m c^2$, *Sec. 2(2)2.* However, typical gravitational energies are immensely lower than the value of $m c^2$ for typical elementary particles [48]. In other

words, mass lost in the form of gravitational fields through gravitational expanding spheres in case of centrally symmetric mass-body at rest on the basis of H particle-paths hypothesis, that is in contradiction with *GRT* in which energy must lost in the form of gravitational waves of moving bodies.

III) "The gravitational Einstein's field equations are not linear; thus, the principle of superposition is not true for gravitational fields contrary to electromagnetic field in special theory of relativity"[1] *part 95*, *Note 5(16)1d1*. On the other hand, the negapa (or posipa) as singlet are superimposed on each other in the same direction in case of electromagnetic interactions. Whereas, negapas and posipas move according to counter currency, *Sec. 3(1)2,* in case of gravitational fields similarly to reversible motion of H particle-paths of a mass-body, i.e. gravitational field is expanded form of its related matter; *Note 2(1)3b.*

IV)"Whereas electric and magnetic forces are clearly bipolar, gravity is generally assumed to be always attractive so that no analogous cancellation occurs. Another difference is that the preserve of matter can modify or shield electric and magnetic forces and electromagnetic radiation; whereas, no weakening of gravity has allegedly been measured by placing matter between two bodies, and it is assumed that this is time whatever the thickness of the matter in question"{321], *part 2, shielding*. Please refer also to *Sec. 5(9)3b.* According to *Sec. 5(2)1c, part B,* an interpretation based on slight preference of *SN* configuration over *SP* one, in our expanding matter Universe leading to similarity of gravity with electromagnetism.

V) "Quantum fuzziness springing from the uncertainty relation $[p,x]=-i\hbar$, is apparently not enough to deal with the $1/r^2$ singularity in gravitational force"[461] *Quantum Gravity*.

Note 5(16)1d1- "Relastivistically, for instance, the field equations of electromagnetic (Maxwell's equations) are linear"[461] *Quantum Gravity*.

Comment 5(16)1d1 – "The theory of potential momentum is only one of three ways in which the idea of potential energy can be extended to the relativistic case. This theory is called gauge theory. Gauge theory is important because electromagnetism as well as the theories of weak and strong such nuclear interaction, are all of this type" [422]. Factually, the single direction H particle-paths belong to Bosonic group, whereas reversible one to fermionic one, *Sec. 3(1)2, Fig. 3(4).* Noteworthy, an intermediate stage is related to a combined part of single & reversible directions as in *Fig. 3 (5).* As an example, we can refer it to a gravitational field of a rotating mass-body, e.g., the Earth. Thus, the single direction part can be led to an additional phenomenon nominated gravitomagnetism, *Sec. 5(2)1c*, in the gravitational interaction. According to above discussion, the gauge theory, *Sec. 2(4)3*, can be applied merely to single direction H particle-paths.

Remark 5(16)1d1- "These are a few theories proposed by physicists which claim suggest electromagnetism can wrap time and spaces although these theories have gained very little support from other physicists. For example, the physicist Burkard Heim posited that electromagnetic energy was interchangeable with gravitational energy" [350], section of *Special Manipulation of Electromagnetism*. According to H particle-paths hypothesis any experiment that convert the counter-current reversible H particle-paths to single direction one as singlet (or vice versa) can be done this interchangeability. It is a direct proves of the idea that the Universe is constituted of a single stuff, i.e. H particle-paths, *Sec. 2(1)1d*; please refer to *Sec. 5(2)1c, part B*. "In physics, Kaluza-Klein theory is a model that seeks to unify the two fundamental forces of gravitation and electromagnetical. Theodore Kaluza who extended general relativity to a five dimensional space-time. The resulting equations can be separated out into further set of equations, one of which is equivalent to Einstein field equation, another set equivalent to Maxwell equations for electromagnetic field and final part an extra scalar field now termed the radion" [413] *Introduction*.

5(16)1e – Delta Effect and path constancy in gravitational field

It must not confused the path L_G, i.e. the geodetically ellipsoid arc, between two point on the geodesic (or circle) of curvature r^{-1} on the expanding sphere (or closed surface) with that of merely the length of the segment of the latter one. Moreover, the former is conserved during sphere expansion, whereas the latter (circle segment) is increased during expansion proportional to the gravitational sphere radius.

According to the above statement, the segment length reaches the path L_G ultimately at $r\to\infty$. In other words, any gravitational sphere according to *Delta Effect*, *Sec. 2(1)1b, Eq. 2(15), Fig. 2(3),* has its own proper time ΔT_G and path-limit Γ_G during its expansion respect to an observer at Euclidean space (Nil gravitation). At the end, the proper time and path-limit Γ_G related to expanding sphere coincide with that of the Euclidean space at zero curvature i.e. rectilinear. In addition, this phenomenon is explained in general theory of relativity as space-time curvature.

Generally, space-time curvature in the general theory of relativity is a continuous media, i.e. with null gap, which is in contradiction with the quantized space of the gravitational field in case of H particle-paths hypothesis. Since, H particle-paths arrangement structure in case of non-moving mass-body is as a stationary wave-like microstructure, i.e. a collection of ellipsoids arc geodesic, at path-limit Γ_G on the gravitational surface. Moreover, a gravitational sphere expands radially at a deceleration rate, proportional to r^{-1} *Sec. 5(9)2.*

To any point, of an H particle-path moving at c speed trajectory, and on the geodesic of a expanding gravitational sphere (e.g. circle), we can relate a non inertial reference frame which its origin coincide with the center of gravity of mass *M* at rest, rotating in the direction of the stated above geodesic. In other words, the axis of rotation is perpendicular to the geodesic arc or circle plane. As the sphere expands, its frequency or rate of rotation ω decreased accordingly till sphere radius, $r\to\infty$, $\omega\to 0$; thus,

the reference frame convert to Euclidean or better to say pseudo-Euclidean one. In other words; this point has variable metric and space-time, *Eq. 2(15),* respect to an observer at rest during expansion.

According to path constancy through mass, and related gravitational field media, we have:

$$L_t = N_0 \Gamma_{mass} = n_s \Gamma_{G1} \qquad 5(67)14a$$

Considering $\Gamma_{mass} = \frac{c}{a_{mass}}$, *Sec. 7(4)3*, part *D*, and $\Gamma_{G1} = \frac{c}{a_{G1}}$, we have:

$$\frac{N_0}{a_{mass}} = \frac{n_s}{a_{G1}}$$

According to *Note 2(3)1a, Eq. 2(56)*, we have:

$$K_\Gamma = \frac{n_s}{N_0} = \frac{a_{G1}}{a_{mass}} \qquad 5(67)14b$$

Where:

- a_{G1}, in this case is the media coefficient a, *Note 1(2)1*, related to the first gravitational sphere at the instant at its birth, *Fig. 5(8)* (ground sphere)
- Γ_{G1}, the path-limit of the ground sphere

Generally, path-limit of the n^{th} gravitational sphere Γ_{Gn} is obtained as following:

$$\Gamma_{Gn} = \frac{c}{a_{Gn}} \qquad 5(67)14c$$

By increasing $n \to \infty$, $\Gamma_{Gn} \to \Gamma_d$, i.e. path-limit Γ_d of gravitational field free vacuum. At this case, a_{Gn} is reached to a_d, the media coefficient of vacuum gravity free medium, *Sec. 7(4)3, part A*, i.e. a flat medium. Referring to *Sec. 5(16)1b, part A, Fig. 5(8),* the curved path of L_G at its maximum curvature on ground gravitational sphere tends to flatness by increasing n. While, the length of its curved path in each cell is remained unchanged through successive n increasing, i.e. Delta Effect, *Sec. 2(1)1b,* in a gravitational field based on path constancy, *Sec. 2(1)2*. As a result, the radial distance between any successive gravitational spheres is decreased by n increasing up to continuity. Therefore, the tangential distance Γ_{Gn} of the cell is increased by n increasing up to that of flat vacuum medium; while, the path L_G is remained unchanged. Noteworthy, the number n can be by a far analogy to the principal quantum number of hydrogen atom according to Bohr model. Please refer to [452], and *Sec. 5(7)6* in this regards.

5(16)2- Singularity at event zone and expansion

5(16)2a – General aspect

A) Preliminary steps

In fact, we encounter with a singularity at Schwarzschild sphere in the point of view of its related time interval, Δt_s, *Sec. 5(16)1b, part A, paragraph 9,* in the general relativity. However, according to mass *M* loss in the form of expanding spheres, *Sec. 5(1), Note 5(1)1a, Sec. 5(4)*, a special case may be occurred that need to a more investigation. Moreover, the H particle-paths of the field exchange as integer number of h, during field-mass interaction, *Sec. 5(2),* i.e. consistent with quantum theory, and contrary to field continuous variation without any gap in the theory of general relativity.

Inside the horizon of Schwarzschild sphere, as ground gravitational sphere, the H particle-paths reflect back by that of expanding spheres, i.e. n_G collection according to Mirror Image Effect, *Sec. 6(2)3*. In other words, infalling and outgoing H particle-paths move generally toward the singularity region i.e. $r = 0$, at c speed. As a loose analogy, we can compare the H particle-paths back reflection by reflection of the light in a dense transparent or, high refractive index media. In respect of H particle-paths hypothesis that has no so hard link with space-time curvature as in general relativity, the Schwarzschild surface can be regarded as an event horizon of gravitational sphere with a expansion pressure that is in equilibrium with the internal H particle-paths. Moreover, the latter moving at c speed inner the Schwarzschild sphere, i.e. a legacy from early Universe, *Remark 5(16)2a1*. By a loose analogy, it can be compared to the gas molecules in a closed vessel in which the gas molecules are in mutual interaction, (or exchange), from point of view of its H particle-paths exchanging with that of the atoms of the wall of the container according to Newton's third law, *Sec. 6(2)3*, at a constant pressure. Considering, *Sec. 11(1),* assuming the pressure on the wall of container as the radial direction parts of interacting H particle-paths of gas molecules this example may be more clarified.

During exit of the H particle-paths through the Schwarzschild surface, as ground state of gravitational sphere, we encountered with a reduced pressure inside the former that is compensated by reducing of its radius, l_s, *Eq. 5(31),* down to reach to a pressure as latest one. This process is continued successively along with l_s contraction, *Consequence 5(16)2a*; thus, at each stage the pressure inside the Schwarzschild surface remain unchanged, *Example 5(17)1. W*e can compare this with a rubber air balloon that at any time by exit of some of its air to outside, its internal pressure compensate by balloon contraction and remain constant, i.e. equal to the outside air pressure, *Note 5(16)2a1*.

According to *Eqs. 5(7), 5(31), 5(35),* supposing an object of rest mass M_n and Schwarzschild radius, l_{sn}. Now assuming a gravitational sphere (or expandon, *Sec. 5(16)1c, part A3*) is exited from it; at this stage its mass and Schwarzschild radius are M_{n-1} and l_{sn-1}, respectively in such a manner that:

$$\frac{d\,l_s}{l_s}=\frac{l_{sn}-l_{sn-1}}{l_{sn}}=\frac{M_n-M_{n-1}}{M_n}=\frac{dM}{M_n}=\frac{dr}{r_n}=\frac{1}{3}\frac{dV}{V}$$

$$=\frac{n_G}{R_n n_G}=\frac{n_s}{R_n n_s}=\frac{n_s}{N_0}=R_n^{-1}=-\frac{8\pi^2 G}{Ac^3}\left(\frac{a_s}{b}\right),\ \textit{Comment 5(16)2a1}\qquad 5(67)15a$$

According to *Sec. 5(16)7b, Eq. 5(70)8a1,* and *Sec. 5(16)1a, Eqs. 5(55)1, 5(52)*:

$$\frac{d\,l_s}{l_s}=\frac{dM}{M_n}=\frac{d\alpha}{\alpha}=-H_o\,d\tau=-\frac{8\pi^2 G}{Ac^3}\left(\frac{a_s}{b}\right)=-\frac{\pi c}{c_p}\left(\frac{a_s}{b}\right)=R_n^{-1}=-K_\Gamma,\ \textit{Sec. 5(16)2a, part B}\qquad 5(67)15b$$

Please refer also to *Sec. 5(16)7b, part A*, and *Note 5(16)2a2*. According to above results, the gravitational constant G depends inversely on the R_n. In other words, during the n increment or whole Universe expansion the G value will be decreased accordingly; while $G\,A^{-1}$ remained unchanged, *Note 5(16)1c, A1, part B*.

Where:

- α, *Sec. 2(1)1a, Eq. 2(7),* the single direction H particle-paths to that of reversible one (deviation degree from reversibility)

K_Γ - The proportionality factor of matter wave frequency

- $a_s=1s^{-1}$, *Note 1(2)1,* $b=1kg^{-1}, u=1m^{-1}$ of inverse dimensions based on units of dimensions in *SI* units.

-*dM,* The mass loss, or, the mass equivalent of the mass *M* field related to H particle-paths of the gravitational spheres laying between the radii r to $r+dr$, *i.e. volumes V* to *V+dV*. Please refer to *Note 5(16)2a3*.

- M_n - Initial mass equivalent at the instant of generating the *n'th* gravitational sphere on the Schwarzschild surface l_{sn}.

- r_n - The radius of the n_{th} gravitational sphere at present time.

- $d\tau$ - Discretized time's arrow interval, or, in other words, unit of gravitational time's arrow variation, *Sec. 5(16)1c, part A4*.

- c_p- is the relationship between stress-energy and the curvature, *Sec. 5(16)3g, Remark 5(16)3g, A1.*

Please refer to *Sec. 5(16)3g*, *Remark 5(16)3g, A2.*

-*A*, Correction factor, *A= 0.9262*; please refer to *Sec. 5(16)1c, part A1*.

Thus, according to *Eq. 5(55), 5(67):*

$$-d\log_e l_s=-\frac{1}{3}\log_e V=\frac{d\,l_s}{l_s}=\frac{8\pi^2 G}{Ac^3}\left(\frac{a_s}{b}\right)=\frac{\Gamma}{L_G}=\frac{\pi c}{c_p}\left(\frac{a_s}{b}\right)=\textit{constant}\qquad 5(67)15c$$

According to *Eq. 5(67)15c* and *Sec. 5(16)1c part A, Eq. 5(67)6*, and integration between two instants t_2, t_1 in whole three-dimension space, *Sec. 2(4)1, Remark 2(4)1b,* we have:

$$\int_{t_1}^{t_2} d\log_e l_s=-H_o\int_{t_1}^{t_2} d\tau=-\int\frac{8\pi^2 G}{Ac^3(b)}.d\tau=-\frac{\pi c}{c_p(b)}\int d\tau \qquad t_2-t_1=a_s^{-1}=1s$$

$l_s=F_1 e^{-\frac{8\pi^2 G}{c^3(b)}}+F_2$ at initial condition $t_1=0$, $l_s=0$, we have: $F_1=-F_2$

In case of mass unit, *M=1* and referring to *Eq. 5(31),* i.e. $l_s=\frac{G}{c^2}$, $b^{-1}=1kg$, and after expansion $e^x-1=x+\frac{x^2}{2!}+....$where

$x=-\frac{8\pi^2 G}{Ac^3}(\frac{a_s}{b})=2.1\times10^{-34}\left(\frac{a_s}{b}\right)$ and considering higher order ox ,i.e. x^2, x^3,....are negligible; therefore:

$$l_s=\frac{c}{8a_s\pi^2}(1-e^{-\frac{8\pi^2 G(a_s b^{-1})}{c^3}})=\frac{c}{8a_s\pi^2}(1-e^{-2A\hbar(bu^2a_s^{-1})})=\frac{c}{8a_s\pi^2}(1-e^{-A\|2\hbar\|}) \quad \text{and} \quad F_1=-\frac{c\,a_s^{-1}}{8\pi^2}\ \text{or}\qquad 5(67)16$$

$$l_s=\frac{c}{8a_s\pi^2}(1-e^{-\frac{2A\hbar}{s_u}})\approx\frac{Ach}{8\pi^3(a_s S_u)}=\frac{Ac\hbar}{4\pi^2}(bu^2a_s^{-2})$$

Thus, l_s in *Eq. 5(67)16,* is constrained by path-length unit $\hbar$ (or the lowest possible path-length, *Sec. 5(16)1a, Remark 5(16)2a3*). In other words, path-length value h of an H hall package, *Sec. 5(16)3a,* depends on the singularity imposed by the geometry of space and time as in Schwarzschild radius, *Note 5(16)3a3*. In case of unit of mass, please refer to *Sec. 5(16)3g* in this regards; moreover, the Schwarzschild radius, L_s in its general form of a mass *M* can be obtained as follow:

$$L_s=M(b)\,l_s\approx\frac{AMc\hbar}{4\pi^2}P_u^2=\frac{AMCh}{8\pi^3}\left(\frac{b}{S_u}\right)\qquad 5(67)17$$

According to *Eq. 5(67)17; Sec. 5(8)2, Eq. 5(33)1,* we have:

$$S_s = 4\pi L_s^2 = \left(\frac{AMc}{4\pi^2}\right)^2 \frac{h^2}{\pi}\left(P_u^{-2}\right) = \frac{A}{\pi}(Mc)^2 l_p^2 P_u^{-2} \qquad 5(67)18$$

Therefore, Schwarzschild surface is restricted by square of Planck length (or square of Planck constant h).

In case of a black hole, *Eq. 5(21)d*3, its entropy *S* will be:

$$S = \pi k_B \left(\frac{l_s}{l_p}\right)^2$$

Where:

- S_u , action unit, i.e. $S_u = 1b^{-1}u^{-2}a_s$; please refer also to *Sec. 2(4).*

- P_u , linear momentum unit, i.e. $P_u = \left(\frac{a_s}{bu}\right)$

- L_s , Schwarzschild radius of mass *M*

- k_B , The Bolzman's constant

-*C*, capital, the path that light travel in on second

According to above discussion, [*Eq. 5(67)15a*.], the rate of mass diminution continues exponentially down to the last gravitational sphere on the surface of Schwarzschild sphere, i.e. evacuation of the event zone entirely from H particle-paths.

In fact, singularity of gravitational potential, *Note 5(4)1b,* in the Newton gravitational law, space-time in case of general relativity in event zone are analogous to that of potential electric field, *Sec. 4(5), last paragraph*, at the point of charge, that is lost its physical aspect in viewpoint of H particle-paths hypothesis.

At the event zone, none of the H particle-paths can not be left individually the Schwarzschild surface but an agglomeration of n_G ones moving at c speed according to counter-currency mode, *Sec. 3(2)1*. They can cut their links to the other H particle-paths inside the Schwarzschild surface, i.e. escaping simultaneously all together in an expanding process from that zone as a gravitational closed surfaces, *Remark 5(16)2a1*. Considering the *Mirror Image Effect*, *Sec. 6(2)3,* the escaping of an expanding sphere of n_G H particle-paths towards the outside of event zone is accompanied by a contraction of a sphere of n_G impulsion H particle-paths of reversed handedness (or contracton, *Sec. 5(2)1c, part c*) toward the inside, *Remark 5(16)2a2*, *Note 5(16)3a3*. It is along with l_s diminution as stated above to compensate the pressure drop in an oscillating behavior of H particle-paths motion, *Sec. 7(4)4,* at a frequency according to *Sec. 5(16), Eq. 5(53),* and *Sec. 5(16)2b*. This phenomenon has a distinct effect in case of high-density massif object, i.e. black hole, *2o6*. Noteworthy according to above statement, there is an oscillating motion, *Sec. 5(6)2,* (or beat, *Sec. 7(5)3d, part D*) inner the mass due to exit of each gravitational sphere, *Note 5(16)2a4*. By a far analogy, this phenomenon can be compared to acoustic oscillations of the photon-baryon fluid, *Sec. 5(5)1*, radiation pressure from photon [comparable to single direction H particle-paths due to radial motion, *Sec. 5(16)1b, part A, Fig. 5(8)*]. It resists the gravitational compression of effective mass of the fluid [comparable to counter-current reversible H particle-paths of tangential motion, *Fig. 5(8)*] into potential wells.

In fact, space-time is the manifestation of wave-like motion of H particle-paths moving on the gravitational sphere outside the event zone, but inside the latter; as the H particle-paths losses their wave-like arrangement as individual ones, the space time also losses its meaning or sense.

Consequence 5(16)2a1 - Factually, at this stage the handedness reversal, *Sec. 5(16)9b,* is take place on the surface of event zone. In other words, the gravitational spheres expand in a right-handed manner along with right-handed H hall package increment due to left-handed contraction, *Sec. 5(16)7a, Consequence 5(16)7a1*, of H particle-paths of the related mass. Therefore, it is along with l_s contraction down to newly ground gravitational sphere (or event zone); please refer also to *Sec. 5(16)1c*, *part A*, *Consequence 5(16)1c, A1,* and *Sec. 5(16)9d*. As a result, the handedness reversal depends on the singularity at the event zone (or Schwarzschild sphere, *Note 5(16)3a3*). Referring to [291], *page 92*, in accordance with Gold view of the fate of an astronaut falling in black hole, "The arrow of time should suddenly reverse upon his crossing the horizon, and he will experience all the miracles of the counter-clock world". Noteworthy, the Schwarzschild surface (or event zone) is a barrier, *Note 5(16)3a3*, that separate mass from its related gravitational field. According to *Sec. 5(15)2b*, the released of n_G H particle-paths in the form of expandon is compensated by H particle-paths of dark matter, *Remark 5(15)2b*. Please refer also to *Sec. 5(16)1c, part A1*. Noteworthy in our type *R* matter Universe, the spatial expansion is performed right-handedly of SN_r configuration, *Sec. 5(16)1b, part A, Paragraph 7B*; whereas, their spatial contraction because of Mirror Image Effect, *Sec. 6(2)3*, must be performed based on SP_l configuration due to handedness reversal, *Sec. 5(16)9b*. Please refer also to *Sec. 3(1)2, Comment 3(1)2b*, and *Note 5(16)2a3*. Moreover, naturally the fermion has SP_l configuration in matter Universe and SN_r configuration in antimatter one. Please refer also to *Sec. 5(16)1b, paragraph 17, Remark 5(16)1b, A4.*

Note 5(16)2a1- At the case of black hole, only the H particle-paths in the form of expanding sphere moving at c speed on its surface at tangential counter-currency mode of motion, *Sec. 3(1)2,* can leave the event zone as gravitational field. Whereas the single direction ones as that of the light trapped inside event zone cannot escape from that. As a result, the latter acts as a dense medium or, a barrier (e.g. wall) for the former (i.e. light). In other words, in case of event zone and gravity high as black hole the

time interval according to *Sec. 2(1)1b, Consequence 2(1)1b1, case 3(A),* lost its usual conception and must be replaced as in, *Sec. 5(16)1c, part B.* Please refer also to *Sec. 7(4)3, part D.*

Note 5(16)2a2- According to *Eq. 2(103)1a* of *Consequence 2(4)1a*, K_Γ is equal to $2\|\hbar\|$, where $\|\hbar\|$ the magnitude of reduced Planck constant and can be regarded as an immutable constant. Therefore, if Hubble parameter varies (that is constant at present time, i.e. H_0) during the Universe evolution, $d\tau$ will be varied accordingly in such a manner that their product remain unchanged. In other words, according to H particle-paths hypothesis, the Hubble parameter during the Universe evolution depends inversely merely to the gravitational time's arrow or time-slice of the Universe, i.e. $d\tau$. According to *Note 7(4)1a,* it is proportional to ΔT_Γ, i.e. Universal quantized time unit.

B) Comparison of the deviation degree from reversibility and cosmological factor

The expression $\frac{1}{3}\frac{dV}{V}$ by analogy to case of [1] *sections 107,108* is equal to $\frac{d\,a_{(t)}}{a_{(t)}} = dlo\,g_e a_{(t)}$. Where, $a_{(t)}$ is the scale factor according to *FLWR* equations. Therefore, according to *Eqs. 5(67)15a, b,* we have:

$$\frac{d\,l_s}{l_s} = \frac{dM}{M_n} = \frac{d\alpha}{\alpha} = \frac{d\,a_{(t)}}{a_{(t)}} = R_n^{-1} = -K_\Gamma = H_0 d\tau = \text{Constant, } \textit{Note 5(16)2a2}. \qquad 5(67)19$$

Therefore, the scale factor $a_{(t)}$ of *FLWR* equations that is based on *GR*, and the deviation degree from reversibility α that is based on H particle-paths hypothesis are equivalent. Please refer also to *Sec. 5(16)7b, part A*.

According to *Note 2(1)4b*, $\frac{d\alpha}{d\tau} = \overset{o}{\alpha}$ can be considered as acceleration. Thus, referring to *Remark 5(15)1b*, the acceleration per unit of α, the ratio of single direction H particle-paths respect to reversible one, nominating deviation degree from reversibility, *Sec. 2(1)1a, Eq. 2(7),* can be interpreted as Hubble constant H_0 at present time. Therefore, $K_\Gamma . d\tau^{-1} = H_0$ can be interpreted as the rate of expandon emission per unit of deviation degree α during unit of time-slice $d\tau$ of the Universe. Noteworthy, according to [513], "The Friedman equation gives $\Lambda_0 \approx H_0^2$, the subscript 0 denotes the value of the quantity at present epoch". "$\rho_v = \Lambda / 8\pi G$ Represent the energy density of emptiness (vacuum) at present time $\rho_{v0} = 10^{-47} GeV^4$. Please refer to *Sec. 5(16)3c,* in this regards. According to above discussion, the cosmic scale factor $a_{(t)}$ by comparison to α can be interpreted from viewpoint of H particle-paths. According to [514], *The Equations*, the first Friedman equation is as following:

$$H^2 = \left|\frac{\overset{o}{a}}{a}\right|^2 = \frac{8\pi G}{3}\rho - \frac{k c^2}{a^2} + \frac{\Lambda c^2}{3} \qquad 5(67)20$$

It is justified in scales larger than ~100Mpc. Where, H, the Hubble parameter (the rate of expansion of the Universe. Moreover, a, H, ρ are function of time.

According to above discussion, and *Eqs. 5(67)19, 20*, the hard link between $a_{(t)}$, and α is leading to the dependence of K_Γ to the actual (or observed) density ρ related to matter content in the Universe, and cosmological constant related to its dark energy. By the difference that in the *Eq. 5(67)15b*, H_0 depends to the first order of G; while, according to *Eq. 5(67)20,* to the root of G.

Note 5(16)2a3- Any two successive n_G groups related to massless dM are handedness reversal, *Sec. 5(16)9b,* of each other. They have individual SN_r and SP_l configurations of equal path-length magnitude and opposite sign with slight preference of the SN_r respect to SP_l configuration in spatial medium, *Sec. 7(4)3, part A*. It is along with equivalent slight preference of the SP_l configuration respect to SN_r one within related mass medium, *Sec. 7(4)3, part D*, in our matter Universe; please refer also to *Comment 7(4)2e1*.

Note 5(16)2a4- According to *Sec. 5(9)3d, part c, Fig. 5(5)2*, any expandon emission by mass-body 1 related to the exit of its gravitational spheres in spatial medium is along with contracton transfer to the mass-body 1 by interacted mass-body 2 or vice versa. Therefore, any beat of gravitational sphere, *Sec. 7(5)3d, part D*, is along with equal path-length magnitude of contracton transfer of contracting characteristic via common H hall package towards the emitter. Noteworthy, the expandon and its contracton conjugate are due to split of dark matter; please refer to *Consequence 5(16)2a1*. "Every particle sends quantum waves outward, and receives an inward response from the Universe"[503] *Part 2*.

Comment 5(16)2a1- According to *Sec. 5(16)1b, part A, paragraph 19*, every $\delta l_s = d l_s / n_s$ diminution related to a n_s cell on Schwarzschild sphere constitutes a common H hall package tunnel with that of preceding cells in a cone-like cavity up to a gravitational interaction. The apex of the cone-like cavity is located on the related n_s cell. According to *Sec. 7(5),* the item δl_s is nominating cavity reverson, *Sec. 7(5)2b, item H*. The successive cavity reversons δl_s in a cone-like cavity constitute a common H

hall tunnel from the apex of the cone-like cavity. According to *Simulation 7(4)2e1*, in a cavity each cell related cavity reverson of common H hall package tunnel emits successively a type W_R or W_L expandon during stay time ΔT, *Sec. 7(4)2f, part A*. It is along with type W_L or W_R contracton respectively that transfer spontaneously within the common H hall package tunnel to the *G*-reverson and accumulate there up to an interaction. During interaction, the aggregated contractons are transferred ultimately to the related supermassif black hole, *Sec. 5(7)8*, and irreversibly absorbed there. Factually, the cavity reversons are surrounded with cell of type $R \,\&\, L$ successively as its axeon, *Sec. 7(5)2b, part D*.

Remark 5(16)2a1 – "Space-time singularities that arise in gravitational collapse are always hidden inside of black hole. This is the essence of the (weak) cosmic censorship conjecture. The destruction of a black hole's event horizon is ruled out by this principle because it would expose the inner singularities to distant observers"[324]," The black-hole event horizon may be classically unstable Whereas absorbing charged object. This suggests that the purely classical law of general relativity do not enforce cosmic censorship. The stability of the black hole event horizon depends in an essential manner on quantum effects. This suggests that cosmic censorship might be enforced by a quantum theory of gravity"[339], *part IV, conclusions*. However, according to H particle-paths hypothesis there is a correlation between H particle-paths inside the black hole and the expanding gravitation spheres through its event horizon, *Sec. 5(16)1c, part A1, Eq. 5(67)6*.

Remark 5(16)2a2- In fact, Schwarzschild surface in a normal mass can be regarded as sum of the axeons, *Sec. 10(8)*, of their atomic and molecular constituents, *Eq. 5(67)18*. Therefore, this back reaction [i.e. contraction of n_G (or n_s) H particle-paths] is transferred to these that are restricted in H hall quantized package, *Sec. 5(16)3a*, of path-length square magnitude of h, *Sec. 5(16)3g*. Thus, leading to acceleration of the normal mass-bodies (or particles), according to the whole Universe expansion stream. This form of mass conversion of dark matter to gravitational field through normal mass (that resulting to space expansion) is accompanied by acceleration of the latter that is referred to dark energy, *Sec. 5(15)2*.

5(16)2b –Expansion from viewpoint of H particle - paths

According to phenomenon of radially forward motion of H particle-paths to Schwarzschild surface and its backward reflection (oscillation) during exit of gravitational spheres cited in *Sec. 5(16)2a,* it depends on the characteristic of rest mass (i.e. fully reversible part of H particle-paths). Therefore, the atomic structure physical specifications (e.g., electric charge, mass of the particle, atomic radius…) at the rest state remained unchanged. In other words, the emitted photon (e.g., fully single direction H particle-paths) wavelength as in case of *CMB* is a function of time's arrow and increase during spatial expansion, i.e. redshifted. Whereas the energy levels and atomic physical specifications magnitude at rest state related to reversible part of the atoms (or its ingredients) conserved during time's arrow; please refer to *Sec. 5(15)2*. In fact, during expansion, the single direction H particle-paths populations in the H hall quantized package, *Sec. 5(16)3,* of a photon is decreased in a phenomenon similar to *Sec. 7(2)*. In other words, the H hall quantized package is split to multiple H hall quantized packages (related to particle track texture, *Sec. 5(16)3b, part B,* generation) according to cosmological redshift at the same rate as vacuum quantized texture, *Sec. 5(16)3b, part A*. It leading to space generation along with time's arrow, *Sec. 5(16)7a*, and decrement of density of vacuum space quantized texture, *Sec. 5(16)3b, part A*. Therefore, according to *Sec. 5(16)3b, part D2, item VIII,* the path-limit Γ of photon in its H hall quantized package is elongated. Please refer also to *Sec. 3(1)1, Figs. 3(2), 3(3),* and *Sec. 5(16)3b, part F.*

According to above discussion and referring to *Sec. 5(15),* both reversible H particle-paths (*category A*) and single direction H particle-paths (*category B*) participate in spatial expansion but, with different rates during which the entropy of the whole Universe increase accordingly, *Sec. 5(16)9b, Sec. 5(16)9c, part B*, . In the latter case, the splitting of H hall quantized packages performed on the basis cited in, *Sec. 8(9), Fig. 8(1),* (entangled pair of photon measurement of emitter source, *Remark 5(16)2b1*); therefore, the redshift is the result obtained by detector during such a measurement, *Sec. 8(7)2,* i.e. emitting photon Unique H system collapsing by the mass-bodies(e.g., stars, galaxy, etc. are taken as detector or observer) interactions.

Therefore referring to above discussion, we encountered with two types open and close counter-current H particle-paths as following:

(I) According to *Sec. 8(7)2,* and *Fig. 8(1),* before measurement the entangled pair of photon constitute an open single direction counter-counter-current H particle-paths, *Sec. 3(1)2, Fig. 3(4)a, b*, of *SP & SN* configurations. After measurement we have single direction H particle-paths *Sec. 3(1)2, Fig. 3(4)c,* i.e. *SM* configuration; as an example we can refer to Microwave background radiation, *Sec. 5(5)2,* of open counter-current H particle-paths.

(II) According to *Sec. 5(16)1b, part A, Fig. 5(8),* before interaction with mass-body (measurement), the expanding spheres contribute a closed counter-current H particle-paths of *SN* configuration, *paragraph 15, Sec. 5(16)1b, part A*, i.e. *CF* Force-line. After interaction, we have a *Gravitational Dome, Sec. 5(2)1a*, formed of single direction H particle-paths; as an example of closed counter-current H particle-paths one can refer to Dark matter, S*ec. 5(1)2*.

Remark 5(16)2b1 (proposal) – Similarly to the *case II*, related to expanding spheres generating on Schwarzschild surface, *Sec. 5(7)1*, of the mass-body. The entangled pair of photon emitted by the source in a one-dimensional path can be supposed initially as a compact unique H system at a wavelength of the order of Planck length, *Sec. 5(1), Eq. 5(33),* that expand to its ultimate normal wavelength just after emission in a path-limit Γ, (after measurement by observer). This unique H system that is constituted of open single direction counter-current particle-paths at *SN* or *SP* configuration, *Sec. 3(1)2, Fig. 3(4)a, b,* that extended at two opposite directions, undergoes cosmological redshift (after measurement by observer in future time at cosmological scale) according to *Sec. 5(16)2b*. Moreover, a colliding photon with a mass-body can be assumed to be contracted as a compact H system (i.e. its wavelength contracted down to Planck length) at the Schwarzschild surface of the latter during striking. It undergoes Handedness reversal at this stage as a compact mirror image, *Sec. 6(2)3*, at Planck length; thus, expand and reflected

back as reversed handedness of initial photon before striking along with time's arrow reversal during collision time. Please refer also to *Sec. 5(16)10*.

5(16)2c - Gravitational refraction (proposal)

A) General aspect

"A matter wave impingent on a discontinuity in potential momentum is refracted, just as it is refracted by a discontinuity in potential energy. Refraction of a matter wave packet means that the velocity of associated particle changes as it moves across the interface. This means that the particle undergoes an acceleration, implying that it is subject to a force" [424]. The velocity of massless photon in gravitational potential remained constant, i.e. c. Moreover, its wavelength is changing, *Secs. 5(9)1, 5(10).*

Supposing a lift as in Einstein general theory of relativity is moving at V speed respect to an observer O at rest a narrow beam of light entered through hole S_1 on the right side of lift and normal to it, *Fig. 5(9),* as following:

I) If $V=0$; the light beam travels S_1A_1paths and strike at left side of lift at $A1$.

II) If, $V= v = Const$; the light beam must be striking at A_2 respect to observer O, but according to limited value of speed of light and *Delta Effect, Sec. 2(1)1b, Eq. 2(12*), it strike at $A_2^{'}$ in the direction of v, or, in other words, the beam light refracted respect to observer, O' inside the lift. Moreover, S_1 coincides at S_2, the new location of the hole after upward displacement.

III) If $V=nv$ (step like motions) up to $V=v_f<c$ according to *Eq.2(12),* by increasing $n=2,3,4,\ldots n$; we have successive contraction due to *Delta Effect*, *Sec. 2(1)1b, Fig.2(3),* accompanied by speed V increasing related to n successive accelerated motion, i.e. at α , *Eq. 2(7),* variable, *Sec. 2(1), Note 2(1)4b.* In other words, instead of straight line $S_2A'_2$, *(n=1)* we have a polygon like of n straight sides that are surrounded by a curve with a curvature opposite of axis ox' respect to observer O' inside the lift.

IV) In an accelerated mode of steady motion of V increasing, according to $V=0$ to v_f , the light beam instead of traveling a straight line paths as in stages *I to III,* bended respect to O'. Moreover, according to stage (*III)* $n \to \infty$ successive steps imply that each step related to the entrance of a single direction H particle-path during successive accelerating motions. In other words, n coincide with the number of entered H particle-paths.

According to the above statements, we can compare each of the above states with the light refracted by a transparent media; *Sec. 5(16)3i, as*:

1) The step *(I)* can be assumed of vacuum medium with no refraction.

2) The step *(II)* can be compared with media with constant refractive index η

3) The step *(III)* can be compared with n parallel successive media at increasing refractive index as $n \times v \approx n\eta$

4) The step *(V)* may be compared with a media that its indices of refraction increased continuously.

5) As the light beam speed (i.e. c in the vacuum) decreased through transparent media, by regarding its refractive index, it will be decreased with a comparable manner during its travel through gravitational field regarding the magnitude of the latter. Moreover in these cases we have mutual interaction of single direction H particle-paths of the light beam with that of transparent media and gravitational field respectively according to Mirror Image Effect, *Sec. 6(2)3*, *Delta Effect*, *Sec. 2(1)1b, and, Note 5(16)2c, A1*; please refer also to *Sec. 5(4)4,* and *Sec. 5(16)2c, part c.*

As a result, uniform or constant indices of refraction related to uniformity of matter constituents (or H particle-paths geometry and density) that is compared with that of uniform gravitational field, and so variable refractive index can be compared with variable H particle-paths population density in the gravitational field. In fact, H particle-paths of the gravitational field can be regarded as expanded form of the mass, *Note 2(1)3b*.

According to *Note. 4(6)2, Eq. 4(28),* the photon during its travel in a dense media can be visualized as particle at rest mass moving at $v<c$ and wavelength $\lambda < \lambda_{vacuum}$. This phenomena can be attributed to the reversible-like motion of H particle-paths of the photon at c speed during its multiple reflection in the dense media, *Sec. 2(10)1, Comment 2(10)1b,* and *Sec. 5(4)4,* and analogous to the particle of rest mass m. By the way, the speed of photon of the light v in a dense media can be calculated according to following equation:

$$\eta = \frac{c}{v} = s^{-2} \quad \text{, Remark 5(16)2c, A1} \qquad 5(68)1$$

Where:

s -the scale factor, *Eq. 5(38)8.*

η - Refractive index in this region that depends on mass M and distance r, *Note 5(10)1b.*

c- Speed of the light in vacuum.

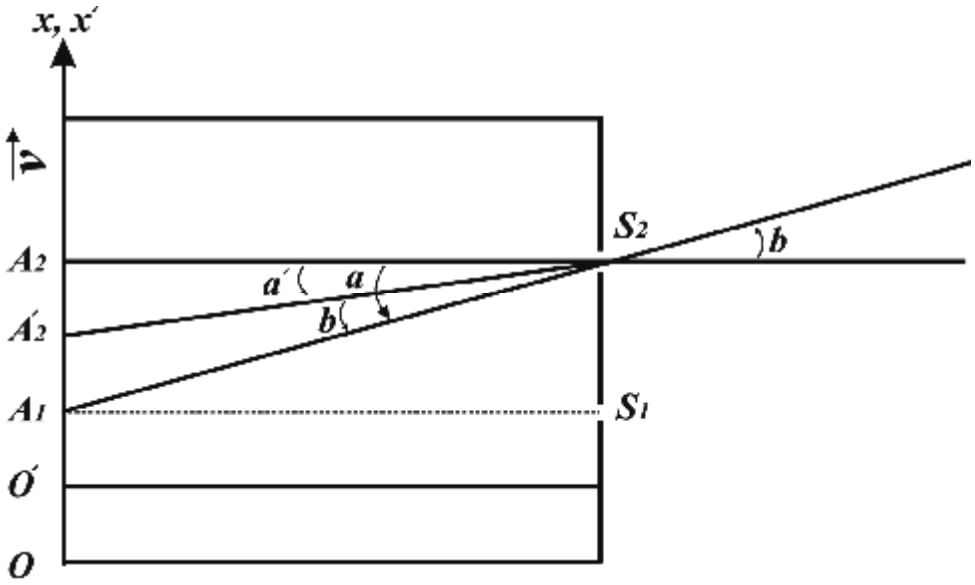


Fig. 5(9) - The light beam refraction

Generally to each point of gravitational field potential we can relate a refractive index, *Eq. 5(68)1*, *Comment_5(16)2c, A1,* the apparent speed of light through that is equal to v. *Sec. 5(4)4*; please refer also to *Sec. 5(4)3, Remark 5(4)3a*. Moreover, the geometry of this medium is on the basis the geometry of the field. This example is given merely for the comparison of the light speed in the dense medium and in vacuum by analogy with that of the gravitational field medium. Whereas according to *Sec. 5(16)1, Fig. 5(8),* the speed of light analogous to the speed of H particle-paths is equal to c regardless of the strength of the gravitational field. Thus, instead of v speed, *Eq. 5(68)1*, we can apply this formula according to time dilation between two clocks in which one is inside a nil gravitational field and one is deep inside a gravitational field as following:

$$t = t_e \times s \qquad 5(68)2$$

$$l = l_e \times s \qquad 5(68)3$$

Where:

t - Time or clock rate in a gravitational field

t_e -Time (or clock rate) in external (or nil gravitational fields) fields, or, background time's arrow, *Sec. 5(16)1c, part c*) of the related medium

l - Length scale in a gravitational field

l_e - Length scale external to the gravitational field or nil gravitational fields.

Please refer to [62], part related to gravitational effect upon the clock rate.

Thus, according to *Sec. 2(1)1b, Eq. 2(15) and Eqs. 5(68)2, 3,* we have:

$$\frac{l_e}{t_e} = \frac{l}{t} = c\,, \qquad \textit{Comment 5(16)2c, A2} \qquad 5(68)4$$

In other words, v will be equal to c and remain unchanged independently of the field strength along the curved (or non-rectilinear) path. However, identical result formally will be obtained based on, *Eq. 5(68)1*, assumption through a curved or refracted path respect to rest observer o with its own time t_e as the light speed measured in a glass.

Probable existence of the aether drag, *Sec. 5(4)3,* that is assumed as a positive result through Dayton Miller interferometry measurements [90] may be applied to the oriented flow of free moving H particle-paths (*20 Km/sec, Remark 5(16)2c, A2*) in space of solar system respect to the Earth frame that can be regarded as two following possibilities:

I) It can be interpreted as an example of dense medium related to H particle-paths population density respect to net vacuum as stated above (gravitation side effect). Generally speaking, we are encountered with interaction of the expanding gravitational sphere of the Sun and that of the Earth, i.e. the Earth-centered non-rotating (quasi) inertial frame*, Sec. 2(6)2b*. As a result, this mutual field-field interaction appear as an H particle-paths flows respect to the Earth frame during its linear orbital motion that affects the light beam in the interferometer as fringe shift; please refer to *Sec. 5(9)3*.

II) Based on null result of *Dayton Miller Experiment* in the vacuum and its positive result in the ordinary atmosphere [94, 98], *Section 2-12*, (or other gases, e.g., helium, in the Illingworth Experiment [101]) the relative motion of the Earth respect to *CMPRF, Sec. 2(6)2b*, of the solar system, i.e. approximately the Sun-centered non rotating (quasi) inertial frame. According to which, one can deduced that the relative motion of the Earth (lab) is transferred through the walls of the arm of the interferometer to the air medium in the arms of the latter by successive collision of air molecules with that of the walls. Hence the *LFRF*, *Sec. 2(6)2c*, of the air must be considered respect to the *CMPRF*, of the Sun. In other words, the single direction H particle-paths of the test light beam interacts with that of reversible H particle-paths of the air molecules, *Comment 5(16)2c, A3*; moreover, the main outcome is the derivation of the origin of the Miller k^2 factor in the expression for time difference for light traveling via the orthogonal arms. This factor is equal to:

$$k^2=\eta\left(\eta-1\right)^2 \qquad 5(68)5$$

Where; η is the refractive index of the gas through which the light pass [98] Section1; by analogy, one can use k^2 factor for refractive index of gravitational sphere H particle-paths around a mass-body *M* respect to that of the vacuum, i.e. $\eta=1$.

According to H particle-paths hypothesis the refractive index analogy, *Note 5(16)2c, A2*, along with interaction on the basis of Mirror Image Effect, *Sec. 6(2)3*, a modification of Newton's third law is the best method of interpretation of gravity. It must not be confused with simply light refraction through a transparent medium, which depends on its wavelength, and that is given as a comparison, *Sec. 5(16)2c, part B*. Noteworthy, at the former case the photon is refracted with mass (i.e. atoms, molecules as fully reversible H particle-paths) in the latter case by counter-current H particle-paths of gravitational field (i.e. field as expanded form of the mass, *Sec. 2(1)3, Note 2(1)3b*). Factually, H hall quantized packages, *Sec. 5(16)3a,* have the same curvature of its related H particle-paths that can be interpreted as space-time curvature. The uncertainty principle, *Sec. 7*, is valid for H hall quantized packages and their related H particle-paths through overlapping characteristic of H hall quantized packages via related H particle-paths number of left- and right- handedness. As an example superimposing n H hall quantized packages containing each one H particle-path of non-dense medium; i.e. an H hall quantized package containing n H particle-paths of dense medium, *Sec. 7(2).*

In fact, H particle-paths in the empty space may be considered analogous to Wilhelm Reich Orgone hypothesis as a new form of energy that existed in living organism and the atmosphere and was postulated to exist in cosmic space as well, with properties remarkably similar to Miller Aether [109]. According to this exception, H particle-paths moving in all of the cases at c speed on a background of huge expanding gravitational spheres due to the galaxies. Moreover, the motion of the Earth and the Sun in space mainly is due to internal single direction H particle-paths of their masses rather than external background H particle-paths, i.e. dynamical Aether [102].

Note 5(16)2c, A1- During complete reflection of a single direction H system (e.g. light or photon) by a rigid body surface, besides the mutually exchange of their H particle-paths the spin of photon is reversed, or, better to say a posipa of the beam is exchange by negapa of the rigid body and vice versa. The same phenomenon is occurred during interaction of a light beam and an external gravitational field, *Sec. 6(2)3.*

Note 5(16)2c, A2- "The special *GR* effects (light-bending, gravitational red-shift, radar time delay, pericenter advance) are provided by an optical, light-carrying medium called *Elysium* through the phenomenon of refraction because gravity makes the medium denser near masses" [482]. Please refer also to *Sec. 5(2)1e*.
Comment 5(16)2c, A1- According to [103] part related to *space-time curvature*, Eddington ([104], *page109*), was already aware of the mostly equivalent 'refracting medium' explanation of *GR* features, which retains Euclidean space and time in the same mathematical formalism. In essence, the bending of light, gravitational redshifts, Mercury perihelion advance, and radar time delay can all be consequences of electromagnetic wave motion through an underlying refracting medium that is made denser in proportion to the nearness of a source of gravity"[105], *pages 62-67*; please also refer to [103]. "According to Einstein's theory, a gravitational field is identified with space-time curvature. Also, in an analogous way, it can be considered as a retarder, a deflector and a lens simultaneously, i.e. as an inhomogeneous refractive medium of index $n(r)$ acting upon the propagation of the light rays along a trajectory between points in space-time. Moreover, an optical refractive medium cause a time delay (proportional to n), a deflection of the light rays (through the spatial gradient of n) and the appearance of lensed images". "The effect of gravity is make the medium optically denser in the vicinity of a mass and hence the coordinate speed of light diminished as we approach the mass". "The refractive index, $n(r)$ with the boosted linear Schwarzschild metric at first order *w.r.t.* v/c and u/c^2:

$$n(r)=1-2\,u/c^2-4(v/c)\,u/c^2$$

Where, $u=-GM/r$ is the Newtonian potential" [438] *Interpretation of the 2002 Jovian Observation*"
According to [125] *section 5*, "the author explains the light deflection of remote stars by the solar energy field, using the classical phenomenon of refraction. Cure's calculations show a much better agreement with Merat's empirical law of solar light deflection, than Einstein's calculations".

Comment 5(16)2c, A2- At the case of event zone, *Sec. 5(16)2a,* according to *Eq. 5(38)8*, *s,* is equal to zero; thus, we encounter with a singularity considering, *t, Eq. 5(68)2; l, Eq. 5(68)3*, at this zone. In this case, please refer to *Sec. 5(16)1b, part A, paragraph 9.*

Comment 5(16)2c, A3 - The damping effect of the Earth gravitation on the gas molecule motion (i.e. the side effect of H particle-paths of the Earth gravitation spheres) is diminished by increasing the altitude from sea level. In other words, the fringe shift is became relevant by increasing the altitude for the sake of relative motion of gas molecule medium respect to *CMPRF* of the Solar system as a unique moving H system along with a supposed fixed, *LRFR* on it.

Remark 5(16)2c, A1- Shapiro* showed that the gravitational potential of the Sun causes radar signals reflected back from Venus and Mercury to be delayed, the amount of delay shows that the speed of light is decreased by two units of the scale factor. That is, the computed gravitational scale factor described above affects the speed of light by the square of the scale factor"[62]. Furthermore, according to the above experimental results, the dependence of refractive index to square inverse of scale factor, *Eq.*

5(68)1, and comparing the latter with that of, *Eq. 5(68)2, 3,* we conclude tat the interactions of the H particle-paths of the field and light depend on a bi-dimensional area, e.g., gravitational sphere surface.

Remark 5(16)2c, A2 - According to [90], part related to *Michelson, and others* "One fifteenth of *300 Km/sec.* is *20Km/sec*., a result the author dismissed as they apparently had discarded the concept of an Earth-entrained aether, which would move more slowly closer to sea level; please refer also to *Secs. 5(4)3, 4"*.

B)- Internal H particle-paths geometrical shape of a particle, or, mass-body through gravitational field

Based on *Sec. 5(16)3b, parts B, C, D,* a particle obeys the expanding combined track texture, *Consequence 5(16)2c, B1*, in a medium, e.g. vacuum plus gravitational field. In other words, in case of normal vacuum, the track texture obeys the rectilinear vacuum quantized texture, and in case of the gravitational field, it follows a curved track according to the gravitational field texture. Please refer also to *Sec. 5(16)1b, part A, paragraph 16*. Factually, the single direction H particle-paths of a photon (or a particle) through the rectilinear vacuum gravitational field free quantized texture, *Sec. 5(16)3b, part A*, are straight. In other words, according to *Sec. 5(2)1b*, during photon motion, the entrance of *CF*-lines of rectilinear vacuum quantized texture is along the exit of straight *CI*-lines from the particle, but at opposite direction, i.e. an equilibrium stage, *Comment 5(16)2c, B4*. Similarly, in curved gravitational field medium texture at equilibrium stage, the *CF*-lines have the same geometrical shape as *CI*-lines, but at opposite direction. In other words, the single direction H particle-paths of photon acquire the curved geometrical shape of gravitational medium texture, *Fig. 5(8)*. Analogous to photon, The internal H particle-paths of mass-bodies or particle of rest mass acquires the form of gravitational field medium texture along the direction of motion through the latter medium, *Sec. 5(2)3*. It is based on Mirror Image Effect, *Sec. 6(2)3*, and path-constancy, *Sec. 2(1)2,* at a reversal mode, at microscopic scale in the order Γ_{mass}/Γ_d. Where, Γ_{mass}, Γ_d are the path-limit within mass, and vacuum media respectively, *Sec. 7(4)3, parts, D, A,* analogous to film projection on the screen in the movie, *Note 5(16)2c, B1*. Moreover, according to *Sec. 7(4)2e*, the particle's (or mass-body's) matter-wave counterpart traces the track texture of their, Sec. *5(16)3b, parts B*, *D*, through the spatial medium. Resuming, the H particle-paths motion, *Sec. 7(4)4,* direction within the mass medium, *Sec. 7(4)3, part D*, of photon (or mass-body) acquires the same geometrical shape as the gravitational field medium, *Sec. 7(4)3, part B,* at equilibrium stage. Ultimately, at vacuum non-gravitating medium, *Sec. 7(4)3, part A,* the H particle-paths of photon or mass-body recovered the same shape as vacuum rectilinear quantized texture medium at a reverse processing along with track texture through the spatial medium.

Consequence 5(16)2c, B1- According to *Comment 5(2)1b1, item 2*, the light beam as in *Sec. 5(16)2c, part A* obeys the combined track texture, *Sec. 8(3)4b*, of vacuum H hall package and that of gravitational field that is based on *Sec. 5(2)1b, Fig. 5(2).* Factually, the photon main-body H particle-paths interact with that of combined track texture, *Sec. 7(4)2f, part E*, in order to reach equilibrium, *Sec. 5(2)1b*.

Note 5(16)2c, B1- Based on *Example 7(5)2a1*, analogous to case of photon emission from a source, the path-limit Γ_d in spatial medium, *Sec. 7(4)3, parts A*,*B*, traces the microscopic negative track of path-limit Γ_{mass} in mass medium, *Sec. 7(4)3, part D*, at the form of reverson.

Comment 5(16)2c, B4- Any rectilinear *CF*-lines of vacuum quantized texture through mass m medium, *Sec. 7(4)3, part D*, has a curvilinear (or whirlpool-like) path towards the center of mass (or denser part of mass) up to Schwarzschild surface of the mass m. It is reversed back as *CI*-lines of handedness reversal along with geometrical shape reversal. Similar scenario also is holding of curved *CF*-lines of an external gravitational field related to mass M through the mass medium m that is not shown in *Fig. 5(1)* for reason of simplicity. Factually, the frequency equivalent number n of a mass body, e.g. mass m, *Note 2(3)1a, Eq. 2(56),* is an averaged number through the mass m medium. Similarly, the internal time interval ΔT_{mass}, *Remark 2(2)1b,* of mass m is an averaged time interval. Noteworthy, according to *Sec. 2(1)1a, Fig. 2(1),* the formal motion of H particle-paths through mass m at rest state is assumed as straight motion of H particle-paths at c speed at any direction, and at any location without any preference.

***C)*- Virtual gravity due to accelerating motion**

Based on *Sec. 5(9)3d, part c*, the contractons releasing related to the lift floor (or its front side) are in opposite direction of its acceleration by analogy to *Sec. 5(16)1b, part A, Fig. 5(8),* and contracton releasing related to the force (or collision) application are in opposite side of the lift floor, i.e. an antigravity on this side. Or, in other words, virtual gravitation and anti-gravitation fields related to both direction of accelerating motion. Moreover, the released contractons are along with equivalent compact expandons emission, *Sec. 6(2)6b, part B,* and *Remark 10(6)1*during collision or force application. Please refer also to *Sec. 5(3).* According to above discussion, the mechanical interactions, e.g. collision, force application, have intrinsic analogies with the gravitational interactions. In other words, the inertial mass is equivalent to gravitational mass, *Sec. 5(3)*. Factually, gravity is related to mass-field interactions; while, mechanical interactions are related to mass-mass interactions. Noteworthy, according to *Sec. 2(1)3, Note 2(1)3b*, the mass is contracted form of the field, and field is expanded form of the mass. Based on *Sec. 5(16)1b, part A, items 26, 27,* the true gravity is related to expandons emission and contractons releasing during permanent steady successive beats, *Sec. 7(5)3d, part D*, of the related mass in all directions. While, in case of accelerating motion, the contractons releasing and expandons emission are in the direction of acceleration that ceased by removal of acceleration. Thus, nominating virtual gravity respect to former permanent one. According to *Consequence 6(2)3a*, there are successive recombination of released aggregated contractons, *Sec. 7(5)3d, part B*, and emitted compact expandons of reciprocal interacted mass-body, *e.g. object A*, to

regenerate the single direction H particle-paths in other mass-body*, i.e. object B,* at opposite direction in order to promote the accelerating motion, *Sec. 6(2)1*.