Part 4c- media

7(4)3– The media coefficient a dependence on medium from viewpoint of H particle-paths hypothesis

All properties of H particle-paths of particles and mass-bodies depend on the medium, e.g. spatial medium. At each point in space H particle-paths from all particles in the Universe combine their intensities (or H particle-paths population densities or its path-length densities at a location) to form medium of space. In gravity free vacuum, the medium (or its H particle-paths population densities) is nearly constant everywhere. But in gravitating vacuum near a large astronomical body, e.g. the Sun, the H particle-paths density produces a measurable curvature of the particles, or mass-bodies track texture, *Sec. 5(2)1e*. We observe there as effect of gravity described by Newton. This effect also found in Einstein's general relativity. "Einstein realized that matter is inseparable from the space it occupies"[501] *Part B*. "The entire physical world (motion of all matter) therefore all of science and the Universe, was a result of this property of space. This implied that all matter and motion was contained in one entity-space [501] *Part c*. According to H particle-paths hypothesis, all of the matter and space (or spatial patches, *Sec. 5(16)3b, part H*) are different aspect of H particle-paths. Please refer also to *Sec. 7(4)2f, part E*. H particle-paths hypothesis dealing with different media as following including mass medium that behaves differently from spatial medium. The environment is constituting of different media, e.g. spatial, mass, etc, along with specified characteristic. The word environment simply is applied in some parts of this article; please refer also to *Sec. 5(15)3b, part B, Sec. 8(7)1*, and *Sec. 8(7)2* in this regards. According to H particle-paths hypothesis, the vacuum medium, e.g. free vacuum, gravitating vacuum, are no longer void, *Sec. 5(16)3c*, it is constructed of type $R\,\&\,L$ H hall packages, *Sec. 5(16)3a*, containing wave-like H particle-paths of specified energy. The vacuum acts as a transmission medium. "A medium is a material substance which can propagate energy wave"[505] *Introduction*. In case of discreteness in a medium please refer to *Sec. 8(7)2, part E4*. Moreover, similarly to vacuum, "Electromagnetic radiation can be transmitted through an optical media, such as optical fiber, or, through twisted pair wires, coaxial cable, or, dielectric waveguides, It may also pass through any physical material which is transferred to the specific wave-length, such as water, air glass, or concrete."[505] *Introduction*. The stated above media that are nominated mass media are constructed of reversible H particle-paths of contracting characteristic. While, H particle-paths of vacuum spatial media have expanding character, *Sec. 5(16)11*, nominating expandons.

Considering a general formula as following:

$$\frac{\Gamma}{\Delta T_{\Gamma}}=\frac{\Gamma'}{\Delta T'_{\Gamma}}=c,\ \text{and}\ \Delta T_{\Gamma}=\eta.\Delta T'_{\Gamma} \qquad 7(30)$$

The *Eq. 7(30)* is based on constancy speed of light in different media at microcosm, e.g. a , a'.

Where, $\Delta T_{\Gamma}, \Delta T'_{\Gamma}$, are time's arrow, *Sec. 7(4)1,* related to H hall quantized packages of a particle in two media of coefficients a , a', *Sec. 1(2),* and path-limits Γ , Γ' respectively.

Now, supposing:

Note 7(4)3, A1- The environment is constituting of different media, e.g. spatial, mass, etc, along with specified characteristic. The word environment simply is applied in some parts of this article; please refer also to *Sec. 5(15)3b, part B, Sec. 8(7)1*, and *Sec. 8(7)2* in this regards.

A) In the vacuum space medium of $\eta=1$

Thus, according to *Eq. 7(30)*:

$$a'_d\Gamma'_d=a_d\Gamma_d=c, \qquad \textit{Note 7(4)3, A1} \qquad 7(31)$$

According to *Sec. 2(1)1b,* considering an inertial center of mass reference frame *R′* (or *CMPRF*, *Sec. 2(6)2b*), the observer o' is located at its center of mass origin o'. It is moving at V speed in a linear motion through common xx'*-axis* respect to an observer o located at the origin of another inertial center of mass reference frame *R (or CMPRF*). Considering now, an isolated particle of v speed, e.g., electron have path-limits Γ_d, Γ'_d, and media coefficients a_d, a'_d , *Sec. 1(2),* respect to observer o, o' respectively. Based on this conditions, the *Eq. 7(31)* held through vacuum media quantized textures of *R, R′* respectively, *Sec. 7(4)3, E1*. In other words, any of media coefficients a_d, a'_d have a uniform constant value in the related vacuum medium, and their magnitudes are depending on the inertia of reference frame *R, R′*, and respect to their own observers o, o' respectively on one hand. On the other hand, a'_d has a variable apparent value respect to observer *O'* (or vice versa) based on Delta Effect, *Sec. 2(1)1b*. Factually, a locally fixed reference frame L_e (*LFRF, Sec. 2(6)2c, e*) must be considered for moving electron respect to reference frame *R* (or *R′*) observer. Therefore, the electron motion can be studied respect to its common *CMPRF* with that of *R* (or *R′*) respect to the observer o (or o'), *Sec. 2(8).* It is mostly due to huge inertia, *Note 2(6)1a*, of *R* (or *R′*) respect to L_e which is coinciding with *CMPRF* of *R* (or *R′*). Please refer also to *Secs. 8(9)2, 3* in this regards. In case of the vacuum medium in expanding Universe, please refer to *Sec. 5(16)3b, D2, item VIII*. Moreover, any H hall package of vacuum quantized texture acts as a source of expandon formation, *Comment 5(16)1a, B1*.

In case of entangled pair of particle, e.g. photon, electron, it is correlated through its common axeon, *Sec. 10(8),* as a unique H system, *Sec. 8(5).* In other words, the common axeon is constituted of counter-current H particle-paths as a single entity, *Sec. 8(9)1, Fig. 8(1),* just during an interaction (or measurement, *Sec. 8(7)2*), the individual axeon of each of the particle takes form, e.g., spin up or down. Noteworthy, the path-limit Γ of each of particle must be evaluated respect origin of the common *CMPRF* of the pair located on the center of mass of the pair, e.g. the source *(S)* on the Earth lab, *Sec. 8(9)1*, due to huge inertia of the latter respect to that of the particles. In other means, the real observer of kind *A, Sec. 9(3)2*, must be located on the origin *S*. Therefore,

other observers o, o', and so on can be regarded as observer of kind *B, Sec. 8(9)2, 3*. Note that, if the source-particle is not a an isolated H system and is influenced by another mass-body *M*, an observer located at the origin of common *CMPRF* of *M-S* system can be regarded as observer of kind *A*, and others as kind *B* observer. In case of moving source, please refer to *Sec. 8(9)2*. In all of the above cases respect to the observer of kind *A* of path-limit Γ for all of the particle has a constant value depending on the inertia (or coefficient a) of *CMPRF* at its center of mass. Please refer also to *Sec. 7(4)3, part E1*, in case of track texture of an isolated particle through medium of vacuum quantized texture, *Sec. 5(16)3b, part B*.
Noteworthy, according to *Note 5(15)2c1,* the spatial medium is constructed of expandons each has path-length or spin $+2\hbar$ that is confined in an H hall package, *Sec. 5(16)3b.*

Note 7(4)3, A1– According to *Sec. 1(12), Sec. 2(6)4b, Eq. 2(114)b, and Sec. 5(16)3b, part D2,* coefficient a can be regarded as a characteristic of a medium which depends on the density, and geometry of vacuum quantized texture, *Sec. 5(16)3b, part A*, of the medium at a location. The reversed coefficient a, i.e. a^{-1}, reveals as intrinsic time interval ΔT_Γ at that location in both inertial, and non-inertial reference frames.

B) In the gravitational field medium

According to the strength of the field, or, energy density of the vacuum space in gravitational field, *Sec. 5(16)3c*, i.e. $\eta > 1$, the path-limit Γ (or Γ_d in gravitational field free vacuum space) is curved (or curled up, *Comment 7(4)3, H1*) to Γ' (or Γ_G), *Sec. 5(10)2, Fig. 5(7).* In such a way that, the light speed c remain constant, i.e. ΔT_Γ tends to $\Delta T'_\Gamma$ (or ΔT_G) accordingly.
According to stated above discussion, we have:

$$\Gamma' = \eta^{-1}\Gamma\ ,\ a' = \eta a \quad \text{or} \quad \Gamma_G = \eta^{-1}\Gamma_d\ ,\quad a_G = \eta\, a_d \qquad 7(32)$$

Factually, *Eq. 7(32)* is based on Delta Effect, *Sec. 2(1)1b, Fig. 2(3).* Noteworthy, ΔT_d can be regarded as the time delay of the H system in a single state of vacuum space (or gravitational field) that decreased to $\Delta T'_G$ by increasing a_G according to the strength of a gravitational field. In other words, η can be a function of the field strength that depends on the energy density and geometry of vacuum texture including gravitational field.
According to discussion held in both *parts A, B,* the product of a by Γ in any medium has a constant value. Moreover, a defines the value of path-limit Γ in a medium at a location. Please refer also to *Sec. 5(16)3b, part D2*. Noteworthy, at a limited spatial location of constant coefficient a, the path-limit Γ has also a constant value for all of the particles accordingly. Based on *Sec. 5(16)1b, part A, paragraph 3, Fig. 5(8),* the gravitational (or closed) spheres are the track texture in vacuum medium that manages the motion of a particle both radially, and tangentially through this external texture, please refer also to *Sec. 7(4)3, part E,* in this regards.

C) In the slit gap medium
C1- General aspect

By the way, in case of spatial medium between two edges of a slit (or its gap), the vacuum quantized texture at this location is affected by H particle-paths flow between two edges of the slit, *Sec. 9(2)*. It is strengthen as the slit gap is decreased, *Comment 8(9)1a.* Therefore, the magnitude of a_{gap} in *Eq. 7(31)* is increased, i.e. ΔT_{gap}, *Comment 7(4)3, c1,* of the medium is decreasing accordingly. In other words, at larger gap the coefficient a is equal to that of vacuum by decreasing the gap, we encounter with a new medium, *Note 7(4)3, c1*, along with an increasing media coefficient a up to reach to zero gap (closed slit) related to a mass (or ΔT_{mass}). Similarly, the path-limit Γ of the particle in normal vacuum is decreased according to *Eq. 7(31)* down to reach Γ_{mass}. Please refer to *Sec. 5(16)3b, part D2, item V*. In the above case, the H particle-paths population density of the particle also affects the texture of the gap medium towards a deformed media coefficient a.
Resuming, there are a combined texture of various mediums as following:

I) A low-density texture of normal vacuum medium in front of the slit gap (i.e. between source and slit), the slit gap medium of high-density texture, *part C2,* and low-density texture of vacuum medium behind the slit gap (i.e. between slit gap and screen). This arrangement nominated slit gap effect.

II) An expanding track texture of particle, *Sec. 5(16)3b, part B*, that is superimposed on the texture cited in case *A*, nominated particle effect.

III) From viewpoint of *HPPH*, the mutual interaction of H particle-paths of particle with that of the slit gap medium, *Sec. 7(4)2f, part E*, leading to stay time ΔT, *Sec. 8(7)2, E2*, that depends to the H particle-paths population densities (i.e. different media coefficient a) of the gap medium at a location. Thus according to *Comment 8(9)1*, the stay time ΔT has not a fixed value. Similar argument is also valid for Δx or slit gap, *Consequence 7(1)1*.

As a result, media coefficient a increment (or Γ decrement) during propagation of a particle depends directly on the combined density of textures *I, II.* In other words, the particle obeys this kind of configurations as a pilot trajectory of its motion.
Noteworthy, according to *Sec. 5(16)3b, part D2 , item VI,* the $\Delta E, \Delta T$ values in relationship *Eq. 7(14)* have appropriate various values in different mediums, e.g. normal vacuum, gravitational field medium, mass medium due to the magnitude of coefficient a. Please refer to *Sec. 8(3)* in case of pinhole aperture.

Note 7(4)3, c1- This phenomenon is comparable to some extent to the *Casimir Effect*, *Note 9(2)4*, based on mutual exchange of H particle-paths.

Comment 7(4)3, c1- The path-limit of gap medium is $\Gamma_{gap} = \Delta x$, i.e. the slit gap. By varying Δx, the path-limit Γ_{gap} is varied accordingly. Moreover, $\frac{\Gamma_{gap}}{\Delta T_{gap}} = c$; where, the time interval ΔT_{gap} is equal to a_{gap}^{-1}.

C2- Particle paths coherence

The effect of the slit gap or pine hole, *Sec. 8(3),* medium is dominant respect to the normal vacuum medium, *Sec. 7(4)3, part A,* due to its high-density texture respect to the particle track texture in vacuum medium, i.e. the improvement of coherence from an incoherent light source prior to pinhole aperture. "Coherence of a source can be improved by various physical arrangements and optical components (increasing the distance from the source, focusing and passing light through a small pinhole aperture, etc.). Improved coherence, however, results in drastic reduction of light intensity. When the concept of coherence is mentioned in literature, it usually refers to temporal coherence" [550]. In other words, the paths of initial photon of light obey the conical track textures of pinhole medium on co-axial cones, *Sec. 8(3)*, due to its dominance respect to normal vacuum. Factually, spectrally incoherent light, e.g. white light of a tungsten filament interferes to form continuous light with randomly varying phase amplitude. Therefore, the pinhole track texture medium rearranges the photons from viewpoint of fixed phase-relationship during photon travel through this track texture. The latter track texture obey the arrangement due to beats of gravitational sphere emission, *Sec. 7(5)3d, part D*, of the mass medium, *Sec. 7(4)3, part D*, constructing the frame of pine hole. Noteworthy, the pinhole track texture is taken form during the passage of photons through pine hole. Thus, constructing coherent particle paths on the co-axial cones. Factually, photon paths, Sec. (or track) interfere. "If there is destructive interference, the electron never arrives at that particular position. This ability to interfere is called quantum coherence"[551].

D) In the mass medium

In the mass medium, the *Eq. 7(31)* is also holding:

$$a_{mass}\Gamma_{mass} = c \qquad 7(33)$$

The path-limit Γ_{mass} has its lowest magnitude in mass medium on a surface of Schwarzschild radius l_s, *Sec. 5(8)1, Eq. 5(31),* i.e. Γ_{mass}tends to a singularity $\Gamma_{\sin} = l_s$, *Note 7(4)3, D1*. Therefore, a_{mass} is reached to its maximum value $a_{\sin} = c\,l_s^{-1}$ at this singularity; where, $t_{\sin}$ is the related time. Noteworthy, the border between two types *R&L* universes is the Schwarzschild surface of a mass-body. In other words, on this area, there is equilibrium between the two Universes, one the two is expanding, i.e. *type R*, while the other one is contracting, i.e. *type L*, accordingly. During a collision, *Sec. 6(2)1a*, the interaction is taken place on this bordering. As an example, a *type R* (or *L*) photon during collision on a plate is converted to its conjugate *type L* (or *R*) accordingly due to Mirror Image Effect, *Sec. 6(2)3*. Thus, photon path-length limit Γ_d in vacuum medium is contracted to Γ_{mass} or $\Gamma_{\sin}$ in mass medium, i.e. $\Gamma_d = K_\Gamma^{-1}\Gamma_{mass}$, *Remark 2(3)1b*. In case of black hole, *Sec. 5(7),* $\Gamma_{\sin}$ is tending to $\Gamma_p = l_p$ (Planck length, *Sec. 5(8)1, Eq. 5(33)1*). In other means, $a_{\sin}$ is reached to its maximum value $a_p = c\,l_p^{-1} = t_p^{-1} = \sqrt{\frac{c^5}{\hbar G}}$ at this stage. Where, t_p is the Planck time, *Sec. 5(8)1*, *Eq. 5(33)2*.

Note 7(4)3, D1. -"So far there is no unquestioned proof against the possibility of a particle interpretation for *QFT*. Although there are "N-particle states" among the possible states of *QFT* it is not clear how these states relate to N particles. The pieces of circumstantial evidence against a particle interpretation seem to be strong. The core of these pieces consists in problems to localize "particle states" in any sensible way"[598] *Localization problem* According to *HPPH*, the particles are related to the mass medium. Factually, the path-length of the particle's field are of expanding SN_r configuration in e.g. normal vacuum medium; while, the path-length of the particles are of contracting type SP_l configuration at equal magnitude and opposite signs, *Sec. 5(16)11*. Moreover, the particle are correlated to the suppermassif black hole as mass medium of host galaxies and clusters, Sec. *5(7)8*, through a cell on Schwarzschild surface of the suppermassif black hole via their H hall package tunnels, *Sec. 5(9)3d;* please refer to *Simulation 8(7)2, E5a, Schema E5a*. The Reeh-Schlieder theorem (Reeh & Schlieder 1961) is a central analyticity result in AQFT. From a physical point of view, the Reeh-Schlieder theorem is based on vacuum correlations. What the Reeh-Schlieder theorem asserts is that acting on the vacuum state Ω with elements of the von Neumann algebra R*(*O*),* containing observables associated with space-time region *O*, one can approximate as closely as one likes any state in Hilbertspace H, in particular one that is very different from the vacuum in some space-like separated region *O′*. The Reeh-Schlieder theorem is thus clearly exploiting long distance correlations of the vacuum. Alternatively, one can express the result by saying that local measurements do not allow for a distinction between an *N*-particle state and the vacuum state. The technical statement of the theorem together with introductory and interpretive comments can be found, e.g., in Redhead 1995a"[598] *Localization Problems*. "The localizibability condition is the essential ingredient of the particle concept. A particle- in contrast to a field- cannot be found in two disjoint spatial sets at the same time" [598] *Localization Problems*. Please refer also to *Sec. 7(2)2b,* and *Sec. 7(4)2h*, *Sec. 8(7)2, part E2*, in this regards. Reeh & Schlieder, Hegerfeldt, Malament and Redhead all gained mathematical results, or formalized their interpretation, which prove that certain sets of assumptions, which are taken to be essential for the particle concept, lead to contradictions. However, it is a point of debate what exactly has been shown by these no-go theorems in the end and how the different results relate to one another. Please refer also to *Sec. 7(2)2b,* in this regards.

E) Particle track texture medium

The track texture of this kind is of *P*-expandon type each of its cell (or H hall package) has expanding characteristics of path-length value $2\hbar$ that is accompanied by related contractons. The latter are emitting spontaneously towards the related particle or mass-body, *Sec. 5(7)8*. According to *Sec. 5(16)3b, item IIV*, the particle track texture (or any of its sub-track texture) has a central reverson that is shielded by its axeon, *Sec. 10(8)*, as a singularity, *Sec. 7(5)2b*. Please refer also to *Sec. 8(7)2, part F3*.

E1) In vacuum medium

A) According to *Sec. 5(16)3b, part B*, supposing the main track of particle P between two points A,B, *Remark 2(4)1a*, is constituted of η non-expanded overlapped (or stored, *Sec. 7(4)1, item 3*) sub-tracks each constituted of N H particle-paths, i.e. an H hall package containing *N* H particle-paths. Therefore, the distance AB has rectilinear form in main track and curved ones in related to sub-tracks, *Comment 7(4)3, E1a*. By this assumption, distance AB can be regarded as path-limit Γ_w of track texture medium for main track, and any of sub-tracks. Thus, the media coefficient a_w for any track can be obtained as following:

$$a_w = \frac{c}{\Gamma_w} = \frac{c}{AB} \qquad 7(33)1$$

Where, the line AB is rectilinear for main track, and curved for sub-tracks.

According to path constancy, *Sec. 2(1)2*, we have:

$$c.\Delta T_m.N.\eta = c.\Delta T_S.N \text{ or } \eta.\Delta T_m = \Delta T_S \qquad 7(33)2$$

Where:

- ΔT_m, the internal time interval of the main track in its H hall packages between two points A,B
- ΔT_S, the internal time interval of a stored sub-tracks in its H hall package between two points A,B

Noteworthy, contrary to inequality $\Delta T_m < \Delta T_S$ in all of the overlapped expanded subtracks, the particle's stay time ΔT_P is the same for the main track (supposing constituted of overlapped sub-tracks), and the related expanded sub-tracks. In other words, the particle time travel from point A to B is simultaneous for main and all of its sub-tracks based on path-constancy, thus:

$$N_m.\Delta T_m = N_S.\eta.\Delta T_m = N_S.\Delta T_S = \Delta T_{\Gamma(w)} \qquad 7(33)3$$

Factually, in case of an isolated particle, and according to *Sec. 7(4)1*, the particle stay time ΔT_P of a particle in any of H hall package of its track texture irrespective of geometry of its AB trajectories can be regarded as following:

$$\Delta T_P = \Delta T_{\Gamma(w)} \qquad 7(33)4$$

Where:

- N_m, The total H particle-paths of H hall package of the main track of internal time interval ΔT_m
- N_S, The total H particle-paths of H hall package of a sub-track of internal time interval ΔT_S
- $\Delta T_{\Gamma(w)}$, the total time interval of a main track or sub-track,

Factually, $\Delta T_{\Gamma(w)}$ has an equal value for the main and related individual sub-track of a particle P, i.e. media related to a particle-track texture. Please refer to *Sec. 7(4)3, part E*. On the other hand, according to *Sec. 7(4)2f, part A, Eq. 7(26):*

$$\Delta T_P = \upsilon_P^{-1} = K_\Gamma^{-1}.n_P^{-1} \qquad 7(33)5$$

Where:

- K_Γ, the proportionality factor of stationary matterwave, *Sec. 5(6),* frequency υ_P with that of n_P frequency equivalent of related particle (or mass-body) that is constituted of total number of H particle-paths N_P.
- n_P, The frequency equivalent of a particle constituted of N_P total number of H particle-paths of total energy $E_\tau = E_P$, *Sec. 2(3)1, Eq. 2(56),* and matter wave counterpart total frequency $\upsilon_\tau = \upsilon_P$

As the result, ΔT_P and $\Delta T_{\Gamma(w)}$ are depending on particle mass, velocity in a gravity free vacuum medium, *Sec. 7(4)3, part A*, and H particle-path densities in a medium that reveals as $K_{\Gamma(w)}$. The H particle-paths population densities in an H hall package of a track texture are attenuating at a rate proportional to r^{-2} from the main track up to that of the isotropic vacuum gravity free medium. In an external gravitational field of a huge mass-body, e.g. the Earth, $\Delta T_{\Gamma(w)}$ (or ΔT_P) of the particle is replaced at good approximation with ΔT_{gm} of the gravitational field, *Sec. 7(4)2f, Eq. 7(29)3*. In case of two low mass particles the stay time ΔT_P of each particle can be regarded as combination of their track textures H particle-paths population densities by taking into account the r^{-2} attenuation effect of both particles, i.e. the factor $K_{\Gamma(w)}$ of the combined track textures. Now, supposing an H hall package of reversed handed of AB one, e.g. W_L, *Simulation 7(4)2e1*, is located at distance $\Gamma_w = BC$, and another one at distance CD of the same handedness of AB, i.e. W_R, and so on, *Note 7(4)3, E1a*. Therefore, the particle P at $ABCD....$ trajectory constitutes its expanding track texture through vacuum medium. Moreover, each of the H hall packages, $AB, BC, DC, ...$, is of *P*-expandon type of path-length value $2\hbar$. Factually, a particle during its stay time ΔT_P through vacuum medium emits W_R, W_L expandons successively through its passage in types $R \,\&\, L$ H hall packages (or states), *Sec. 8(3)4*.

B) The set of newly modified vacuum H hall packages constructs the particle track texture after each particle passage. Therefore, this newly formed vacuum texture, i.e. track texture, acts as a deBroglie matter pilot wave, *Sec. 5(16)3b, part B*, for passage of next particles. As results obtained of above discussion, we have:
1) Each particle during its passage regenerates this track texture through the spatial medium.
2) The set of expanding track textures combination from the source of particles up to a detector constructs a medium for particle travel, *Note 7(4)3, E1a*. In other words, the particle chooses any different trajectories from the source to detector at diverse probabilities based on H particle-paths population densities of expanding track texture in the medium.
3) In case of isolated particle in free vacuum with no previous track texture, the particle chooses the track texture that is imposed by isotropic vacuum medium based on its uniform H particle-paths population densities that leading to as sources of expandons generation. Please refer to *part A* of this section.
4) The most probable trajectory is the rectilinear one in vacuum gravity free medium, *Sec. 7(4)3, part A*, and geodetic of space-time in case of vacuum gravitating medium, *Sec. 7(4)3, part B*.
5) According to *Sec. 5(16)3b, part B*, any track texture has expanding characteristic.

Note 7(4)3, E1a- The two points A,B (or B,C **)** can be located on a real location, e.g. on the walls of rigid box, potential well, i.e. $U=\infty$. By analogy to *Sec. 8(9)1*, point *A* can be regarded as source and point *B* as detector in the direction of particle motion. In other words, the particle H hall package is confined between two points A,B, i.e. $AB=\Gamma_w$, *Sec. 7(4)3, E1, part A*. Please refer also to *Sec. 25, page 267* of reference [36].

Comment 7(4)3, E1a- "The probability of a particle appearing at a certain position is based on the sum of all possible paths that the particle can take from point *A* to point *B* (a particle's position should be considered as the quantum superposition of many possible positions. So it makes a kind of sense that a particle's motion path should be a quantum superposition of all possible motion paths)"[559] *Quantum field theory*. Please refer also to *Sec. 8(7)2, part G*.

E2) In potential well and rigid box media
Please refer to *Sec. 8(2)1,* and *Sec. 8(2)2* in this regards. This media by some analogy to free vacuum quantized texture, *part E1*, are constituted of successive H hall package of reversed handedness related to particle's track texture, *Sec. 5(16)3b, part B*. Therefore, a particle during its motion has a stay time ΔT_P, *Sec. 7(4)2f*, in each of the H hall packages. By analogy to *Eqs. 7(26), 7(29)3*, we have:

$$\Delta T_w=\upsilon_w^{-1}=\left(K_{\Gamma w}\right)^{-1}.\left(n_{0P(w)}\right)^{-1} \quad \textit{Note 7(4)3, E2a} \qquad 7(33)6$$

The frequency υ_w is depended on mutual interaction of N_{0P} H particle-paths of particle with that of H particle-paths of H hall package, *Sec. 7(4)3f, parts A, B, D* of the well, or, rigid box media of $K_{\Gamma(w)}$ factor in a location.
Where:
- $n_{0P(w)}$, the frequency equivalent of particle of total number of H particle-paths N_{0p}, and H hall package of path-limit Γ_w.
- $K_{\Gamma w}$, the proportionality factor of stationary matterwave, *Sec. 5(6),* frequency υ_w with that of $n_{0P(w)}$ frequency equivalent of related particle (or mass-body) that is constituted of total number of H particle-paths N_{0P} through rigid box or potential well media W; please refer to *Sec. 7(4)2f* in this regards.
Noteworthy, the particle in each H hall package type *R* (or *L*) during stay time $\Delta T_P=\Delta T_w$, *Note 7(4)3, E2a*, emits *P*-expandons of type W_R (or W_L), *Simulation 7(4)2e1*, successively that is accompanied by related *P*-contracton conjugates as in *Sec. 5(9)3d, part c*. Moreover, the path-length of expandon and its contracton conjugates of irreversible kind, *Sec. 2(4)4b*, are $+2\hbar$, and $-2\hbar$ values respectively, *Comment…* Noteworthy, any increment in rigid box volume, or, the width D in case of potential well leading to newer H hall packages generation in spatial expansion inside the box and the well path D until a constant volume or path D, i.e. equilibrium, *Note 7(4)3, E2b*. It is along with increment of expandons' sources, and contractons formation, i.e. time's arrow, during particle stay time in these newly formed H hall packages (or states). This is leading to entropy, and negentropy *Sec. 5(16)9d*, increments through spatial medium, and mass media respectively. Please refer also to *Sec. 5(15)2b, Diagram 5(1)*. Noteworthy, the algebraic sum of path-lengths of system of particle (or particles), *Sec. 8(7)6*, through spatial medium in rigid box at constant volume respect to observer *A*, *Sec. 8(9)2,* located in the origin of the particles' *CMPRF* is zero, *Consequence 5(9)3d1*. From above discussion, we have the following results:
A) The stay times of a particle in H hall packages (types *R & L*) are infinitesimal that leading to a probable existence of the particle in any H hall package location (or state).
B) Each H hall package in a well or rigid box acts as a source of *P*-expandons generation, *Comment 5(16)1a, B1,* and *P*-contractons formation. The contractons are transferred through H hall package tunnels to a super-massif black hole of host galaxies or clusters, where irreversibly absorbed. In many particles system during collision, *Sec. 6(2)2a*, of any two particles (or particle with wall) their H hall packages are mutually exchanged along with equal reversible path-lengths of h value, i.e. Mirror Image Effect, *Sec. 6(2)3*. Moreover, this kind of path-length contrary to irreversible kind has non-expanding or, non-contracting characteristic. Therefore, it is confining to a single medium, e.g. inertial mass medium.
C) The minimum energy level or ground state is related to the particle's axeon, *Sec. 8(2)3,* and *Sec. 10(8),* at rest state that changing its handedness successively during stay time $\Delta T_{w\Gamma 1}$, i.e., a non-zero kinetic energy of particle at rest state, *Note 7(4)3, E2c*. In the ground state A,B are located on the rigid box wall, i.e. $U=\infty$. At each energy level, the wave matter counterpart, *Sec. 5(6),* of the particle induces additional track texture H hall package (or state), *Note 7(4)2b1*, that are confined

between the box walls. Factually, during any energy increment of the particle (or quanta absorbed by particle), the particle stay time ΔT_P is diminished, *Sec. 7(4)2f*, step-like that leading to an additional particle track texture H hall package, *Sec. 5(16)3b*. Noteworthy, the particle rest energy (or mass) and the dimensions of the well determines energy level (or energy of absorbed quantas). According to *Sec. 7(4)2f, part A, Eq. 7(29)3,* the former related to n_{0p}, the particle frequency equivalent; while, the latter to the related media, i.e. $K_{\Gamma(w)}$. It is better to say that the rigid box and potential well media W are depending on particle (or particles) mass along with conditions imposed by dimensions of the rigid box wall or potential well. As a result, there is a probable existence of particle during infinitesimal stay time ΔT_P merely in a track texture H hall package cell (or state), contrary to the idea that the particle at each instant is fund at each state at a probable manner spontaneously, *Sec. 7(4)2f, part c*. Factually, the rigid box media W is covered by the cells of its track texture at any instant.

D) According to *Comment 8(7)6, A1,* the whole system of a particle (or particles) in a rigid box constitutes a unique H system of h value just during a measurement of the particle (or one of the particles) by a measuring device at a destructive manner. Therefore, the system of particle (or particles) along with its rigid box media can be regarded as a unique H system of path-length value h, i.e. a distribution of H particle-paths population densities of both particle (and particles) and related medium as a single entity. Noteworthy, a unique H system just during its interaction (or destructive measurement, *Sec. 8(7)2*) reveals its path-length value h, *Sec. 5(9)3d, part D*.

E) A fermionic particle of rest mass, e.g. electron, due to its reversible characteristic of its H hall packages (or cells) has H hall package track texture of reversible character. In other words, an H hall package track texture of a fermionic particle changes successively during stay time ΔT_w its handedness from type R to L (or vice versa)in a cell (or location) without any transfer to next adjacent cells, *Simulation 7(4)3, E2a*. While, in case of a bosonic particle of zero rest mass, e.g. photon, due to its single direction characteristic of its main H hall package (or cell) has H hall package track texture of single direction character, i.e. H hall packages of track texture of a bosonic particle of this kind are types $R \,\&\, L$ successively. In other words, a type R transfer to an adjacent right-handed and type L to right-handed one. Note that, two adjacent H hall packages track texture of type R, and L one are separated by a stay time ΔT_w, *Sec. 7(4)2f.* The stated above results are obtained from Pauli Exclusion Principle. According to that in a rigid box, a pair of electron at opposite spin, *Sec. 9(2),* occupies any state, or, cell of the box and the next two electrons cannot enter the same cell, *Sec. 11(1).* Moreover, to each H hall package of track texture that is not occupied by a particle is related an energy ΔE_w, along with time interval ΔT_w, the latter is nominating the stay time of rigid box medium track texture H hall package (or cell). The following results are obtained from above discussion as following:

I) In case of a fermionic at rest, during stay time ΔT_w, a type R cell emits an expandon of type W_R; thus, converting to a type L cell. The latter emits a type W_L expandon, and converted to type R one again, *Comment 7(4)3, E2a*. This process is continuing successively in a cell along with spatial expansion, and time's arrow generation related to expandon H hall package generation, *Sec. 5(16)3a*.

II) In case of bosonic particle of zero rest mass, during stay time ΔT_w, a type R cell emits an expandon of type W_R. Thus, is transferred to adjacent cell and takes type L handedness. The latter emits a type W_L expandon, and transferred to adjacent cell of type R handedness again, and so on. This process is continuing successively in a cell along with spatial expansion, and time's arrow generation related to expandon H hall package generation.

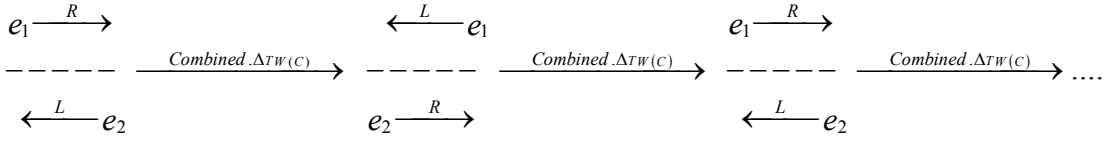
III) In case of a fermionic particle at motion, e.g. moving electron, a combination of the two above cases *I&II* is encountered.

F) The particle track texture in a rigid box medium is the combination of track texture related to box wall potential, e.g. mass medium, electromagnetical medium, in one hand and track texture of the particle in other hand. However, by analogy to *Fig. 5(8), Sec. 5(16)1b, part A* the combined track texture has expanding characteristic through spatial medium from ground surface up to n^{th} closed surface. Moreover, the particle track texture in a cell is regenerated during its occupation by the particle during stay time $\Delta T_{p(E)}$, *Sec. 7(4)3, E1, item1*.

G) The single direction H particle-paths of a particle during its motion in a rigid box, and its collision, *Sec. 6(2)1a*, with the potential wall, e.g. mass medium, are transferred in the mass medium. It is replaced in the latter medium by its equal number of single direction H particle-paths at reversed handedness on the Schwarzschild surface, *Consequence 6(2)3c*, based on Mirror Image effect, *Sec. 6(2)3*, and enters at the point of collision in spatial medium again. Therefore, a cell of type R (or L) is reversed at type L (or R), and forming a combined SM configuration (or H hall package). Similar scenario is applied in case of particle of rest mass during a collision with each other, thus making a combined track texture. Therefore, the track texture cells of the particle in rigid box have SM configuration due to the collision. Factually, this kind of cell of SM configuration can be occupied by a couple of fermionic particles, *Simulation, 7(4)3, E2a, part A*.

Simulation 7(4)3, E2a- In case of two fermionic particles of opposite spins, their combined track texture H hall package, *Sec. 7(4)3, E1, part A*, is of SM configuration. In other words, two types $R \,\&\, L$ H hall packages (or cells) each of SN, and SP configurations respectively are coupled analogous to *Sec. 10(4)1, Fig. 10(1),* by each other in order to built a combined cell of SM configuration. Therefore, if a cell is of SN configuration, the other one has SP configuration, and vice versa during any stay time ΔT_w. Thus, the coupled cell acts like an individual cell, i.e. a unique H system, *Sec. 8(5),* of integer spin of bosonic structure, *Proposal 7(4)3, E2a*. Moreover, the combined cell can be regarded as a cell of SM configuration related to bosons,

Sec. 5(16)3a. Thus, supposing electron e_1 (or e_2) of the pair has type R (or L) character through emission of type WR (or WL) expandon, it converts to type L (or R) one and so on during a combined stay time $\Delta T_{w(c)}$, *Sec. 7(4)2f, Part A,* successively according to the following simulation.



Type R&L configuration (case A) *Type L&R configuration (case B)* *Type R&L configuration (case A)*

Fig. 7 (1) - Schema of system of electron pair of anti-parallel spins in a coupled cell (or orbital)

Please refer also to *Sec. 9(2),* and *Fig. 9(2),* in this regards. In the *Fig. 7 (1)*, the symbol $e_1 \xrightarrow{R}$ represents electron e_1 of the pair in its H hall package of type R characteristic that converts to type L one during stay time ΔT_w to $\xleftarrow{L} e_1$ along with emission of type W_R expandon during stay time interval $\Delta T_w = \Delta T_{p(E)}$. At the same time, the other electron e_2 of the pair that is located in an H hall package of type L converts to type R according to symbol $\xleftarrow{R} e_2$ at opposite spin during stay time ΔT_w. Therefore, the system of electron pair in orbitals of type $R \,\&\, L$ configuration (case *A*) converts to their reversed handedness system of type $L \,\&\, R$ character (case *B*) during combined stay time $\Delta T_{w(c)}$, and continued so on. Moreover, any expandon of type R (or L) during its formation is along with its reversed handed conjugate contracton of type L (or R) releasing.

As a result obtained from the above discussion:

A) Any H hall package of track texture of SM configuration can be regarded as a coupled (or overlapped) of two reversed handedness H hall package of types R, L. Therefore, at any energy level H hall package of SM configuration, one can attributes merely a couple of cells or H hall package, i.e. types R, L ones. In other words, any H hall package on an energy level is terminated to two types R, L of reversed handedness.

B) By analogy to case of gravitational surface (or spheres) of a mass-body, *Sec. 5(16)1b, part A, Fig. 5(8).* The coupled electron pair track textures due to full reversibility of electron pair H particle-paths in a system of many particles, *Sec. 8(7)6*, confined in a rigid box also constitutes the related H hall packages track texture closed surfaces (or spheres) around the origin of *CMPRF, Comment 7(4)3, E2a*, of the system, *Sec. 7(4)3, E4*. Therefore, the pair of lowest energy occupies the track texture closed surface on the singularity of the H system, i.e. ground H hall package cell (or state), *Note 9(4)6a*. The next one on the 1^{th} closed surface up to n^{th} ones at different energy levels reveal as a unique H system, *Sec. 7(4)3, E2, item D*. Therefore, the motion of any pair is restricted to their related track texture.

C) The ground sphere is on the surface of singularity, e.g. Schwarzschild surface of the system. Therefore, similarly to case of gravitational field, the coupled H hall package of types $R \,\&\, L$ emits W_R, W_L expandons and converts to reversed handedness types $L \,\&\, R$ ones. Moreover, any W_R, (or W_L) expandon is accompanied by related P_L, (or P_R contracton) respectively, *Note 7(4)3, E2d;* please refer to *Simulation 7(4)2e1, Sec. 7(5)3b,* and *Sec.9 (4)7*.

D) Any two adjacent H hall package closed surfaces related to two neighboring energy levels are separated by $\Delta T_{w(r)}$ stay time, *Sec. 7(4)2f, part A*, related to radial particle transfer (or motion). Moreover, the particle tangential motion at constant energy surface (or level) is also step-like during stay time $\Delta T_{w(t)}$, *Sec. 7(4)3, E4*. The motion of a particle (or many particles, or, pair of particle) is managed in a rigid box by its path-length that is equal to algebraic sum of other particles path-length at equal magnitude and opposite signs respect to observer *A* at the origin of its *CMPRF*, *Sec. 8(9)2*, by taking into account stay times $\Delta T_{w(r)}$, $\Delta T_{w(t)}$.

E) The mass at rest state is constituted of cells that change their handedness successively from type R to L and vice versa during stay time ΔT_m, *Sec. 7(4)2f, part A*, by the slight preference of type L over type R one through mass medium, *Sec. 7(4)3, part D;* please refer also to *Sec. 7(4)4*. Each cell in any of its type R (or L) configuration has spin or path-length R (or L) respectively. Moreover, stay time ΔT_m varies according to H particle-paths population within the mass medium.

F) According to *Sec. 5(6), item IV,* the combined electron $e_1 - e_2$ system can be regarded as a unique H system, *Sec. 8(5).* Therefore, the system consists of a unique axeon that surrounds a common reverson. Therefore, a mass-body constituted of atoms reveals as a system with central *G*-reverson, *Note 7(5)3b1*. Moreover, In case of fermionic particles, e.g. electron, *Remark 7(4)3, E2a,* any combined adjacent H hall packages in an energy level of coupled pair of electron constructs a condition similar to *item 15* of *Sec. 9(4)7*, in case of hydrogen atom; please refer also to item *G*. Thus, forming a ground state-like in this respect due to a single H hall package related to Pauli exclusion principle, *Note 9(2)2*.

G) According to *Note 9(4)6a*, merely one of the type *R* (or *L*), e.g. (electron e_1, or, e_2), *Remark 7(4)3, E2a,* are in expanding mode during stay time interval $\Delta T_{w(E)} = \Delta T_{p(E)}$, *Note 7(4)3, E2a*; while, other conjugate of electron pair is in contracted configuration of the beat, *Sec. 7(5)3d, part D*. The expanded state is terminated by expandon type *WR* (or *WL*) emission

along with contracton of type *PL* (or *PR*) releasing at its contracting mode during infinitesimal stay time interval $\Delta T_{p(C)}$, *Sec. 9(4)7, item 15,* via H hall package tunnel to related supermassif black hole of the host galaxies, and clusters, *Sec. 5(9)3d, part c*.

Proposal 7(4)3, E2a- Based on *Note 5(16)8a1,* the engaged electron in fermionic mode acts as type $R_e - L_c$ matter Universe, *Comment 3(1)2b*, of path-length value (or spin) $\frac{1}{2}h$, *Remark 7(4)3, E2a*, in a combined H hall package; while, the free electron in spatial medium acts as a boson related to two superimposed type $R_e - L_c$ matter and $R_c - L_e$ antimatter Universes, *Sec. 5(16)9*, with the slight preference of the former in our matter Universe. Please refer to *Note 3(1)2a*. Similarly, *WR & WL* expandons and *PL & PR* contractons act analogous to free bosonic particles with the sum of path-length related to two types of $R_e - L_c$ and $R_c - L_e$ Universes. i.e. $+2\hbar$ in case of expandon, i.e. superimposed *WR&WL* expandons related to two types *R&L* Universes and $-2\hbar$ in case of *PL&PR* contractons, i.e. superimposed *PL&PR* contractons related to two types *R or L* Universes, due to the lack of a firm reverax, *Sec. 7(5)3d, part D*, respect to that of mass medium, *Sec. 7(4)3, parts A, D*. In other words, in case of fermionic particles, e.g. electron pair, their half of the path-length (or spin) value is related to a separate H hall packages of type *R* or *L*; thus, each of the half of the path-length is related to two distinct beats, i.e. not to a single one. Moreover, the free moving photon in spatial medium such as a bosonic particle of path-length value h related to two types of matter and antimatter Universes , i.e. the sum of two half path-length $\frac{1}{2}h$.

Note 7(4)3, E2a- The particle stay time ΔT_P is the same as stay time ΔT_w of the track texture H hall package at the moment that the latter is occupied by particle, i.e. $\Delta T_P = \Delta T_w$, *Eq. 5(70)3a6*. Therefore, the non-occupied H hall package of a track texture is attenuating proportional to r^{-2} from the singularity at the moment of occupation by the particle because of expanding characteristic of the track texture, *Comment 5(16)3b, B1*. As a result, the H particle-paths population densities of an empty H hall package of the track texture is attenuating during the time, and regenerated again during its occupation by particle. Moreover, according to *Sec. 7(4)2f, part A*, the particle matter wave frequency υ_w in a media of factor $K_{\Gamma w}$ depends on H particle-path densities of that media that differs from its matter wave frequency in other media e.g. υ_0 in normal vacuum of $K_{\Gamma(d)}$ factor.

Note 7(4)3, E2b- An H hall package in a well or box can be regarded as superimposition of stored, *Sec. 7(4)1, item 3*, sub-H hall packages. Therefore, by analogy to case of H hall package of a particle, *Sec. 7(2),* during a spatial expansion (or, box volume increment), the main H hall package of track texture is split to sub-H hall packages each of path-length value $2\hbar$, *Sec. 5(16)3b, part B*. During this process, any main *P*-expandon in a main H hall package is dividing to sub-expandons in related sub-H hall packages, *Sec. 5(16)1a, part B*.

Note 7(4)3, E2c- The particle at the stable lowest energy level, i.e. ground state that is related to a singularity, *Sec. 5(16)2a*, has no infinite stay time (or lifetime). But, the particle changes successively its handedness related to its axeon (or spin) in ground state H hall package during any stay time ΔT_{wr1} from type R configuration to type L one along with type R and L expandon emission (or vice versa) respectively, *Simulation, 7(4)2e1*, at a reversible manner, i.e. rest (or stationary) state up to an interaction. Please refer also to *Sec. 7(4)2f, part A*.

Comment 7(4)3, E2a- The origin of *CMPRF* of an isolated system of particles (many particles system, *Sec. 8(7)6*) in gravity free vacuum is located on the center of masses of the system in the related medium, e.g. spatial medium of the box. In case of a rigid box, the origin of the *CMPRF* of the system is located on Earth-particles *CMPRF* origin. In other words, the origin of the latter system is located on center of mass of the Earth due to huge inertia of the Earth respect to the particles. Therefore, the singularities of the system of particles are located on the walls of the box, i.e. on the interfaces of spatial medium, and mass medium that leading to Schwarzschild surface of the Earth, *Sec. 5(16)1b, part A, Fig. 5(8).*

Remark 7(4)3, E2a- According to *Comment 3(1)1b*, the free moving electron spin is equivalent to the minimum possible, *Sec. 9(4)7, item 15,* path-length of a particle, i.e. h. Therefore, the electron in case of a fermionic particle in one of its expanded state *R* or *L*, *Sec. 8(7)2, part G* configuration have half a of magnitude path-length or spin each of opposite sign, i.e. $\pm \frac{1}{2}h$ in related location.

E3) In particle main-body medium

A) In atom's electron shell medium

The atom's electron shell can also be regarded as a medium that H particle-paths of an electron are moving in forwarding and backwarding motion in all directions in related H hall package (or orbitals) according to the latter geometrical shape and H particle-paths population densities. Therefore, the orbitals constituted of moving H particle-paths about the reverson that is surrounded by its axeon, *Sec. 7(5)3b*. It is similar to a *3*-dimensional stationary wave, *Sec. 5(6),* As a result, the proportionality of finding an electron as a point-like particle in a shell can be viewed as its H particle-paths population densities in a location of the shell (or electron track texture, *Fig. 9(3)a*). Please refer also to *Sec. 9(3)1b*, and *Note 9(4)6 b*. "If we begin to think of electron as

waves, we'll have to change our whole concept of what an orbit is. Instead of having a little particle whizzing around the nucleus in a circular path. We have a wave sort of strung out around the whole circle. Now, the only way such a wave could exist is if a whole number of its wavelength fit exactly around the circle. If the circumference is exactly as long as two wavelength , say, or three or four or five, that is great, but two and a half won't cut it"[491]. The photon absorption and emission by an electron in a shell obeys the *Simulation 7(4)3, E2a*. Where, electron e_2 is replaced by a photon. By the difference that photon-electron occupying an orbital, i.e. excited electron H hall package (case *A*, or *B*); while, the photon orbital remained as an empty orbital act. i.e. baby H hall package, *Sec. 7(4)2b*.

As the result:

A) At ground state, the three dimensional electron in the form of H particle-paths moving at c speed around the nucleus in a orbital prevented from further collapsing by a bi-dimensional tiny closed surface of reverson, *Sec. 7(5),* that is shielded by bi-dimensional electron axeon. Please refer to *Sec. 9(4)7,* and *Sec. 9(4)6*.

B) At excited state, the excited electron, i.e. photon-electron system in excited orbital, constructs, similarly to case A a bi-dimensional spatial reverson, i.e. a tiny closed surface around the nucleus that is shielded by bi-dimensional electron-photon axeon during stay time ΔT , *Sec. 7(4)2f, part A*. Please refer also to *Sec. 9(4)6*, and *Sec. 7(5)3b*.

C) At ground state, the electron's spin changes its handedness successively during a time ΔT_e . It is better to say, that axeon of electron around the central reverson of the orbital changes successively its handedness during stay time interval ΔT_e . Please refer also to *Simulation 7(4)2e1*. While, in case of an excited orbital, the excited electron (or photon-electron system) at the end of stay time ΔT_e during handedness reversal of its spin lost its photon. In other words, photon is occupying again its baby orbital, *Sec. 7(4)2b*, at a reversed handedness at the time of its absorption and escaped. Thus, electron obtains its ground state at a reversed handedness of previous excited state. Please refer also to *Note 7(4)2b1*.

D) According to *Sec. 5(6)3,* by analogy to gravitational potential*,* each state due to electromagnetical gradient potential around the central region (axeon), there is a range of wavelength around the central region (axeon), there are a range of wavelength around a central value. "However, a wave like this with definite wavelength is not localized in space, and so cannot represent a particle localized in space. To localize a particle, de Broglie proposed a superposition of different wavelengths ranging around a central value in a packet, a waveform often used in quantum mechanics to describe the wave function of a particle. In a wave packet, the wavelength of the particle is not precise, and the local wavelength deviates on either side of the main wavelength value."[505}*Wave packets*.

B) In zero rest mass medium

According to *Sec. 3(1)2, Fig. 3(4)c,* the zero rest mass particle is of bosonic group, thus has *SM* configuration. Depending on the spatial medium H hall package of type $R\,\&\,L$ configurations, it accepts type $R\,\&\,L$ configurations of path-length value h of equal magnitude and opposite signs without any preference of the type $R\,\&\,L$ configuration. Analogous to case of particles of rest mass, the zero rest mass particles have a contracting path-length. Moreover, the energy of expandon of zero rest mass particle is related to the total energy of the particle main-body by dimensionless proportionality factor K_Γ , *Note 2(3)1a, Eq. 2(56).* The zero rest mass particle, e.g. photon and its matter wave cell (or their related H hall packages), have a common reverson that is surrounded by particle main-body axeon, *Sec. 7(5)3b, item II,* within particle's main-body.

E4) Discussion

According to *Sec. 2(4)4b*, the matter wave counterpart, *Sec. 5(6),* of a particle (or its track texture) has the same origin as its gravitational field. Therefore, in many particles system confined in a rigid box, the track texture of particles constitutes a set of closed track texture H hall package surfaces around the origin of their *CMPRF* as in case of gravitational surface around a mass body, or, atom, i.e. an Unique H system, *Sec. 7(4)3, E2, item D*. It has a similarity to case of electrons in atoms' principal states. According to *Sec. 5(9)3d,* in an isolated system of orbiting mass-bodies, each mass-bodies respect to observer *A, Sec. 8(9)2,* at the origin of their *CMPRF* has equal path-length magnitude respect to algebraic sum of path-lengths of other mass-bodies but at opposite signs. Therefore, the path-length on each orbit can be regarded as algebraic sum of path-length of the other members of the system but at opposite sign. The same scenario is also valid for a many particles system. Therefore, the path-length of a particle on a closed surface of track texture (or path-length surface) at any time interval dt is equal magnitude and opposite sign of algebraic sum of path-length of other particles during the same time interval dt . This process manages the behavior (or motion) of particle both radially, and tangentially in a rigid box. Noteworthy, the path-length of a particle at its lowest energy level is h , the other ones have integer number of path-length value h . During a stay time $\Delta T_{w(r)}$, from a track texture surface a particle or a pair of that is transferring radially to another surface of high energy by absorbing an appropriate quanta of path-length value h or by emission of a quanta from a higher energy to lower one, *Sec. 7(4)2b*. Moreover, on a track texture closed surface during stay time $\Delta T_{w(t)}$, *Sec. 8(7)2, part F3,* a particle is transferring from an H hall package cell to other by emission of an expandon of type W_R (or W_L), *Simulation 7(4)2e1,* along with P_L , (or W_R) contracton formation respectively, *Simulation 7(4)3, E2a, item B*. The energy of an expandon on a closed surface of constant energy (or energy level) is 10^{34} time weaker than the energy of a quanta that emits or absorbed by the particle, *Eq. 2(56) of Sec. 2(3)1a,* from a closed surface to other one. In other words, the irreversible path-length respect to reversible one is in the order of 10^{-34} . As a result, the radial transfer is along with reversible kind of path-length related to *T*-symmetry, *Sec. 2(3)3*; while, the tangential transfer is accompanied by irreversible path-length, *Sec. 2(4)4b*, i.e. time's arrow and, spatial expansion. According to *Sec. 7(4)3, E1, part A,* the closed surface of particle track texture has not a sharp width due to expanding (or dispersive) characteristic of track texture. There is a probability of entrance of a

particle in each of its main, and sub-tracks, *Sec. 7(4)3, E1, part B*. The energy and momentum of a particle during each transition, e.g. radially, and tangentially, are quantized, i.e. its path-length varies by unit of h value.

F) Abstract vacuum medium

Up to this section, an H hall package in any medium has path-length limit Γ that depends on H particle paths population densities of that medium, Sec. 7(4)3, part G. Therefore, a particle has a nominal length Γ in a medium, e.g. photon has length $\Gamma_d, \Gamma_G, \Gamma_{mass}$, in normal vacuum, gravitating vacuum, and mass medium respectively such that $\Gamma_d > \Gamma_G > \Gamma_{mass}$, due to increasing population densities in these media. There is also a medium nominating abstract vacuum, *Sec. 5(16)3h*, medium through which the H particle-paths densities is approximately nil respect to that of normal vacuum. Thus, the path-limit Γ_{abs} within this medium is extremely higher than vacuum medium $\Gamma_{abs} >> \Gamma_d$. According to *Note 7(5)3a1*, merely contractons as a particle can penetrate in this medium and transferring at superluminal speed, *Note 7(4)2f, c2*. According to *Sec. 5(9)3d, part c*, The H hall package in this special case can be regarded as a narrow tunnel within other media, i.e. H hall package tunnel.

G) Path-length, and path-limit Γ in different media

According to *Sec. 5(16)11* the path-lengths in different media, e.g. vacuum, gravitational field, slit gap, are irreversible, and of expanding of type R_e, and SN_r configuration in our matter Universe; whereas, the path-lengths in mass media are contracting of type L_c, and SP_l configuration, and irreversible kind, *Sec. 2(4)4b*. In case of two equal path-lengths (or two equal path-lengths of opposite sign) in different media, the path-limit Γ, *Sec. 5(16)3b, part D2,* of the H hall package depends on the population density of H particle-paths of the related media, *Example 7(4)2f, A1*. Please refer also to parts *A, B,* and *Eqs. 7(31), 7(32)* respectively, *Sec. 8(8)1b*. The H hall package of a particle, e.g. photon, electron, through normal vacuum texture is linked by H hall package tunnel, *Sec. 5(9)3d, part c,* from the source position up to reach a detector *Sec. 7(4)3, part F*. Simultaneously, the media coefficient a within the particle's H hall package is decreasing in such a manner that the *Eq. 7(31)* is holding during particle propagation. Please refer also to *Sec. 8(9), Figs. 8(1), 8(2).* Noteworthy, just during an interaction (or measurement, *Sec. 8(7)2*) that the path-limit Γ takes the normal length of H hall package, *Sec. 5(16)3a*, in the medium of interaction, e.g. vacuum medium, *Sec. 7(4)3, part A*. Noteworthy, the path-limit Γ_d of particle in spatial medium can be regarded as its position (or length) in that medium. After measurement, according to *Remark 2(3)1b*, the path-limit of the particle is diminished from Γ_d to Γ_{mass}. Therefore, the path-limit Γ_{mass} can be regarded as the position (or by loose analogy to particle length) of particle within mass medium; please refer also to *part H*, and *Sec. 7(4)3, parts A, D*. "Before the measurement operation was applied, the particle had no clearly defined position, being stretched-out in space like a wave"[555] *The quantum casino*. Considering classically particle as point-like, its position is along the length of Γ_d or Γ_{mass} in related medium. The track texture in the interference effect, *Sec. 8(3)4*, in the double slit experiment before detection of the particle position can be regarded as all possible positions of particle; please refer also to *Sec. 7(4)3, part c*, and introduction part of reference [555].
Moreover, according to *part E*, the path-length of particle during collision is of reversible kind in a single medium, e.g. mass medium.

H) Numerical values for media coefficient a and path-limit Γ in different media

According to *part D*, *Eq. 7(33),* the least magnitude of path-limit Γ_{mass} is the Planck length, l_p, *Sec. 5(8)1, Eq. 5(33).* Thus:

$a_p = a_{mass} = c\,\Gamma_{mass}^{-1} = c\,l_p^{-1} \approx 1.87\times10^{43}\,s^{-1}$, and it relates to the least ΔT_{mass}, i.e. $d\tau_p$. Therefore:

$$d\tau_p = a_p^{-1} = 5.3\times10^{-44}\,s \qquad 7(34)$$

"Does dark energy defines a new fundamental length scale in physics? $\rho_d \approx 3.8 Kev/cm^3$ (dark energy density), $\lambda_d = \sqrt[4]{\hbar c/\rho_d} \approx 85\mu m$ a second Planck Length?" [468]. Please refer also to *Sec. 5(16)3c,* and *Comment 7(4)3, H1.*
According to this statement and *part A* of *Eq. 7(31)*, in case of nil gravitational field vacuum space, if we suppose:

$\Gamma_d = \lambda_d$, or, R_{vac} , *Comments 7(4)3, H1, H2.* 7(35)

We have:

$$a_d = \frac{c}{\Gamma_d} = \frac{c}{\lambda_d} = \sqrt[4]{c^3\rho_d/\hbar} \approx 3.5\times10^{12}\,s^{-1} \qquad 7(36)$$

The least time's arrow related to the gravitational field free vacuum quantized texture, *Sec. 5(16)3b, part A*, can be obtained as following:

$$d\tau_d = \Delta T_d = a_d^{-1} = 2.8\times10^{-13}\,s \qquad 7(37)$$

Comparing $d\tau_d$ with that of $d\tau_G$, *Sec. 5(16)1a, Eq. 5(51),* that is assumed as the least time's arrow between two successive gravitational spheres, *Remark 5(16)1a2*, we have:

$$\frac{d\tau_d}{d\tau_G} = 3.3\times10^3 \qquad 7(38)$$

Therefore, according to *Eq.* 7(38), in the latter case, we have:

$$d\tau_G = 0.85\times10^{-16}\,s$$

Please refer also to *Comment 5(16)1c, A1*.

Comment 7(4)3, H1- "The observed gravitating vacuum energy density is vanishingly small compared to the predictions of quantum mechanics. The gravitating energy density $\rho_{vac} \approx 0.7\,\rho_c$, inferred from a vide variety of astrophysical observation, is at least 10^{60} smaller than the predicted zero point energy for a cutoff of M_p. The observed energy density corresponds to a length scale $R_{vac} = \sqrt{4\hbar / \rho_{vac}} \approx 0.1mm$ and energy of $\sqrt{4(\hbar c)^3 \rho_{vac}} = 2mev$ that may have fundamental significance. It has been suggested that the apparent inability of gravity to see the vacuum energy could be explained if the effective theory of gravity had a cutoff $\approx 1mev$, so that the gravity would effectively shut off at length scale less than R_{vac} "[470] *Background*.

According to H particle-paths hypothesis, there is a sharp distinction between the vacuum medium of SN_r configuration of expanding right-handed path-length, and mass medium of SP_l configuration of contracting left-handed path-length, *Sec. 5(16)11*. Therefore, the ρ_{vac} (or ρ_c) is confined to the spatial vacuum medium, *Sec. 7(4)3, part A*, and the Planck mass, M_p, to the mass medium, *Sec. 7(4)3, part D*. Where, ρ_c the critical density $3H^2c^2/8\pi G$, and H the present value of Hubble constant through vacuum medium. According to *Eq. 5(51),* we have:

$$d\tau_G = \frac{8\pi^2 G}{H_0 c^3}\left(\frac{a_s}{b}\right) = \frac{3\pi H_0}{\rho_c . c}\left(\frac{a_s}{b}\right) \qquad 7(39)$$

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.

Please refer also to *Note 7(4)2e, B1*.

Comment 7(4)3, H2- According to *Note 2(3)1b, Eqs. 2(77)4, 5,* we have:

$\Gamma_{mass} = K_\Gamma . \Gamma_d = 1.95 \times 10^{-34}$

In case of smallest value of Γ_{mass} in mass medium, *part D*, i.e. the Planck Length l_p, *Sec. 5(8)1, Eq. 5(33),* we have:

$\Gamma_d \approx 82mm$

Therefore, the value of Γ_d obtained according to *HPPH* is approximately *1000* times larger than $R_{vac} = 85\mu m$, *Sec. 7(4)3, part H*.

I) Decrement of media coefficient a during the time

The media coefficient a in a medium is decreasing slightly during the time in a medium. Therefore, according to *Eq. 7(31),* Γ is increasing accordingly. In other words, besides the dependence of media coefficient a to the spatial location of a medium, it varies with the time's arrow in that medium. This is equivalent to positive cosmological constant Λ due to accelerating expansion of the Universe related to dark energy, *Sec. 5(15)2*. Please refer also to *Comment 7(2)1a*. Noteworthy, coefficient a variation during the time has a constant rate that depends on the background time's arrow, *Sec. 5(16)c, item II*, that is identical for normal spatial vacuum and gravitational field. In other words, it depends to vacuum quantized texture, *Sec. 5(16)3b, part A*, that is superimposed on the gravitational field texture, *Sec. 5(16)1b, part A*.

J) The degree of right-, and left-handedness in different media

The different spatial media, e.g. vacuum, gravitational, track texture, etc. are constituted of expandons of type R H hall packages, i.e. better to say type *R* preference over type *L* expandons. During expandons conversion to sub-expandons, the right-handedness of spatial medium is also increasing. In other words, any H hall package of type R is split also to an H hall package of type R with relatively more right-handed respect to latter one along with type L H hall package related to further contracton formation. Similarly, the contracton H hall package within mass medium (or super massive black hole, *Sec. 5(7)8*) is tended to relatively more left-handedness along with further type R H hall package generation related to expandon formation in spatial medium. As the result, the normal vacuum media is tending to relatively more right-handedness, and the mass-bodies (or supermassive black holes) to more left-handedness respect to big bang era. This process is continuing up to maximum spatial right-handedness, i.e. maximum single direction motion of H particle-paths in spatial medium (related to maximum finite entropy) and towards maximum mass-bodies (or super massive black holes) left-handedness, i.e. full reversibility of H particle-paths within mass medium (related to maximum finite negentropy), *Sec. 5(15)2c*. Noteworthy, the degree of right-handedness in expanding spatial medium of SN_r configuration (or dark energy, *Sec. 5(15)2a*) depends on cosmological constant Λ, *Note 7(4)2e, B1*. It increases since big bang, *Sec. 5(5),* epoch up to present time, *Remark 7(4)3, j1*. "Generally, Λ does not play a significant role in the early Universe" [484]. "However, a flat universe at the level we observe ($\Omega_{m0} \approx 0.3$) and a cosmological constant is about *12-16* billion years old, which is compatible with the age of the oldest stars"[485]. Moreover, the degree of left-handedness within contracting mass medium of SP_l configuration of interacting mass-bodies depends also on cosmological constant Λ. It increases since big-bang era up to now; please refer to *Sec. 5(16)11*. The degrees of right-, left-handedness are shown by symbol D_h, *Note 7(4)3, j1*. The *G*-reverson is spreading in the whole of universe mass-bodies, since the big bang era up to present time during the

increment of degrees of left-, right-handedness along with spatial expansion and mass-bodies contraction; please refer also to *Comment 7(5)2a1*.

Note 7(4)3, j1- From viewpoint of H particle-paths hypothesis, the whole Universe is considered as an isolated H system of total energy E_{total} of parameter density Ω_{total}. At the instant of Big Bang, it is regarded as groups of H particle-paths of SM configuration. After Big Bang era, according to *Sec. 5(15)2b*, the SM configurations are split to right-, and left-handed H particle-paths of equal magnitude of path-lengths in spatial and mass media respectively up to a finite maximum level, *Remark 5(5)2b*. Therefore, the degree of right- or left-handedness degree D_h (nominating handedness degree) can be obtained during the time of Universe evolution as following:

$$D_h = \frac{E_\Lambda}{E_{total}} = \frac{\Omega_\Lambda}{\Omega_{total}} \qquad 7(39)1$$

Please refer to *Note 7(4)2e, B1*. Factually, the handedness degree D_h is an average value at a time of Universe evolution. Its highest value in any time of Universe evolution is within the mass media of black holes, and it's lowest in H hall package of an isolated particle through spatial medium. Noteworthy, the D_h degree depends on split ability of H particle-paths of SM configuration to SN_r & SP_l ones.

Where, E_Λ, the dark energy of vacuum medium of parameter density Ω_Λ at the related time of evolution.

Thus, the degree D_h is zero at the Big Bang era and one at the full expansion of the Universe; please refer to *Sec. 5(15)2d*.

At any time of the Universe evolution, the ratio $\frac{E_\Lambda}{E_m} = \frac{\Omega_\Lambda}{\Omega_m}$ is equal to α, the deviation degree from reversibility, *Sec. 5(16)7b, part A*. Moreover, according to *Example 5(16)3a3*, $\alpha \sim a_{(t)} = (1+z)^{-1}$.

Where:

- $a_{(t)}$, The scale factor
- z, Cosmological red-shift
- E_m, The energy related to the total mass content of the Universe of parameter density Ω_m, *Note 7(4)2e, B1*, at any time of its evolution

According to above discussion, and referring to *Note 2(3)1a, Eq. 2(56)*, and *Sec. 5(16)b, part A*, the cosmological constant Λ has a hard link with the proportionality factor K_Γ in the non gravitating normal vacuum. In a homogeneous $FLRW$ universe, according to path-constancy, *Sec. 2(1)2*, we have:

$$E_m.\Delta T_{mass} = E_\lambda.\Delta T_\Lambda \text{, or} \qquad 7(39)2$$

$$\frac{E_\Lambda}{E_m} = \frac{\Delta T_{mass}}{\Delta T_\Lambda} = \alpha \qquad 7(39)3$$

Where:

- α, *Sec. 2(1)1a, Eq. 2(7),* the single direction H particle-paths to that of reversible one (deviation degree from reversibility)
- ΔT_{mass}, The mean of internal time interval of the mass
- ΔT_Λ, The mean of internal time interval related to dark energy or, vacuum spatial medium

Noteworthy, ΔT_Λ is equal to ΔT_d, the quantized time interval of vacuum gravity free spatial medium of path-limit Γ_d, *Sec. 7(4)3, part H, Eq. 7(37)*, at present time. Therefore, if the cosmological constant Λ remained constant, *Sec. 5(15)2c*, during the Universe evolution, according to *Eq. 7(39)4*, the ΔT_{mass}, α are increasing at the similar rate during the evolution time. In other words, the time interval ΔT_d remained unchanged during the Universe evolution. Noteworthy, during Universe evolution, the handedness degree D_h (or deviation degree from reversibility α) is increased through the time. Therefore, D_h is depended on the mean temperature (or energy density ρc^2) of the Universe. In other words, D_h depends also inversely on the population density ρ of H particle-paths during evolution time, i.e. entropy increment.

Remark 7(4)3, j1- Recent results from the Hubble space telescope Higher-Z Team indicate that dark energy has been present for at least *9* billion years and during the period preceding cosmic acceleration" [489] *history*.

K) Wave function density comparison

The magnitude of media coefficient a in a medium depends on the H particle-paths population densities of that medium. It is equivalent to the magnitude of wave function density $|\Psi|^2$, *Sec. 8(1)1,* of quantum mechanic in a medium, and at a location.

7(4)4- Motion of H particle-paths in a medium

Any H particle-path has expanded states, *Sec. 8(7)2, part G*, of two types *R & L* (antinodes, *Simulation 3(1)2a*) and contracted state (node). Moreover, the H particle-paths beats, *Sec. 7(5)3d, part D*, as following:

A) In an H hall package unit, *Sec. 5(16)3b, part A*, the H particle-paths of type *R* expanded state are contracted during stay time interval, *Sec. 7(4)2f, part A,* ΔT to its contracted state; while, transferring to a next H hall package.

B) At the end of case *A*, the H particle-paths again expand to their reversed handed type *L* during stay time interval ΔT and contract subsequently to its contracted state and so on.

C) The combination of H particle-paths in an H system, *Sec. 1(3),* may lead to a closed-end (or reversible) mode of their motions.

D) The combination of H particle-paths in an H system, *Sec. 1(3),* may lead to an open-end (or reversible) mode of their motions.

E) The combination of cases *C & D* H particle-paths in a H system leading to motion of a particle of rest mass in a medium, *Sec. 7(4)3.*

F) The individual beats of groups of H particle-paths in an H system nominating as total population density number of their that are indicated by symbol N in this article. This number also can be indicated by symbol n, nominating the total equivalent number of H particle-paths in a medium for reason of simplicity, *Comment 2(1)1b4*.

G) Each beat related to a state according to *Sec. 5(15)3f,* and can be related to contribution of a parallel universe.

H) Any group of H particle-paths in expanded mode reveals in form of type *R* or type *L* configuration related to type *R* or *L* spin (or path-length, *Sec. 5(16)3g*) respectively with slight preference of type *R* over type *L* in our matter Universe. Factually, type *R* or *L* configuration at their expanded mode emits type *WR* or *WL* expandon in spatial medium, *Sec. 7(4)3, part A*, along with releasing of *PL* or *PR* contracton towards the source or related mass medium, *Sec. 7(4)3, part D*. For further information please to *Remark 1(1)4*, and *Sec. 7(4)2e1* in this regards.

According to *Simulation 8(7)2, item 17D,* in case of a moving particle, e.g. photon, the path $\Delta T_c.c$ is equal to photon transfer in each of its beat, *Sec. 7(5)3d, part D.* In other words, according to *Simulation 7(4)2e1*:

I) In photon case, according to above statement, during a beat, photon is transferred to its next adjacent H hall package, *Sec. 5(16)3b, part A,* (or state), i.e. half a matter-wave of photon wavelength $\lambda/2$ in spatial medium, *Sec. 7(4)3, part A*, and so on.

II) In case of a particle at rest state, during each beat, the particle is transferred to its next state, i.e. its internal H particle-paths are traveled $\Delta T_c.c$ half a wavelength $\Lambda/2$, *Note 2(3)1a*, in mass medium, *Sec. 7(4)3, part D*, and so on. According to *Secs. 7(4)2c,d*, it is along with path-length increment of h value in mass medium. In other words, the particle again jiggles, *Example 5(16)7b, B1*, to its old H hall package or neighboring H hall packages in spatial medium, *Sec. 7(4)3, part A*, based on uncertainty principle.

III) In case *I*, the H particle-paths are nominating moving at single direction (or irreversible) mode at c speed; while, in case *II*, they are moving at irreversible mode of motion per definition, *Sec. 1(3)*.

IV) In case of moving particle of rest mass, please refer to *Sec. 9(4)7*.

Where:

- ΔT_c, the stay time interval, *Sec. 8(7)2, item 17D,* in related medium
- c, the light speed as immutable constant

Resuming, according to *HPPH*, the motion of a particle means the transfer of its H particle-paths in the related medium. Therefore, the concept of motion in microcosm, *Sec.3*, differs from the classical one including *SRT & GRT*. The former depends on the rate of particle state changing.

"Looks like Einstein may have been wrong — An international team of scientists at CERN has recorded neutrino particles traveling faster than the speed of light". "measurements over three years showed the neutrinos moving 60 nanoseconds quicker than light over a distance of 730 km between Geneva and Gran Sasso, Italy". "If confirmed, the discovery would overturn a key part of Albert Einstein's 1905 theory of special relativity, which says that nothing in the Universe can travel faster than light" [621]. According to *HPPH*, a particle, e.g. photon, moving in spatial medium, *Sec. 7(4)3, part A,* has irreversible path-length, *Sec. 2(4)4*, of expanding characteristic of SN_r configuration and time's arrow; while, a particle moving in mass medium, *Sec. 7(4)3, part D*, has irreversible path-length of contracting mode of SP_l configuration at opposite sign to the former and time arrow reversal. Therefore, neutrino contrary to the photon that reflects by the mirror surface can penetrate in mass medium. Thus, its total time travel just during the measurement is reduced respect to that of photon in this regards; please refer also to *Sec. 5(16)11*, and, *Sec. 5(15)2b*. "If neutrinos are traveling faster than light, then neutrinos must be on the other side of the light barrier going backwards in time, where the future can interact with the past." [631] *comment 6*. Factually:

A) Just at the moment of neutrino detection (or striking) by detector, according to *Note 5(16)7, g2,* contractons (as signal) is emitted spontaneously, *Sec. 7(4)2f, part c,* within H hall-package tunnel, *Sec. 5(9)3d, part c*, in backward path of neutrino emission towards the source, *Fig. 5(10),* i.e. completeness of measurement. In other words, the neutrino path is composed of two paths in vacuum and mass media as stated above with two different characteristics path-lengths of opposite sign. Please refer also to *Sec. 5(16)11*.

B) The mass medium of neutrino travel is its detector "The *OPERA* neutrino detector at *LNGS* is composed of two identical Super Modules, each consisting of an instrumented target section with a mass of about *625* tons followed by a magnetic muon spectrometer. Each section is succession of walls filled with emulsion film/lead units interleaved with pairs of 6.7×6.7 m^2 planes of *256* horizontal and vertical scintillator strips composing of target Tracker (*TT*). The *TT* allows the location of neutrino interactions in the target."[623] *section 2*.

C) According to *Note 7(2)2a1,* contrary to particle of zero rest mass, in case of a mass-body, the proper time of *LFRF*, *Sec. 2(6)2c,* must be considered by an observer at the origin of *CMPRF*, *Sec. 2(6)2b*, of neutrino-Earth system that is coincide with center of mass of the Earth due to huge inertia of the earth respect to that of the Earth.

D) Recently*"* Researchers at the University of Groningen in the Netherlands went and crunched the numbers on how much relativity should have effected the experiment, and found that the correct compensation should be about 32 additional nanoseconds on each end, which neatly takes care of the 60 nanosecond speed boost that the neutrinos originally seemed to have. This all has to be peer-reviewed and confirmed, of course, but at least for now, it seems like the theory of relativity is not only safe, but confirmed once again" [625].

As a result, the neutrino like other particles may moves equal or than less than light speed in free vacuum. "The findings may need many runs and checks to be confirmed. Once confirmed, it raises many questions, including why such an effect wasn't noticed before. The big question would be this: What happens to Special Relativity, which is an extremely reliable theory?" [622]; please refer also to *Sec. 2(6)2a*.

7(5)- Reversons

7(5)1- Preliminary step

Similarly to case of P_L & P_R contractons, *Sec. 5(9)3d, Fig. 5(5)2*, between two orbiting mass-bodies, a group of H particle-paths is exchanged at non steady manner between coupled electrons e_1, e_2, *Simulation 7(4)3, E2a*, mass-bodies during their handedness reversal up to an interaction. Factually, according to *Consequence 2(4)4b1*, any reversible path-length is along with an irreversible path-length at an energy ratio K_Γ (and vice versa). In other words, any expandon W_R, or W_L of the coupled electrons, e.g. chemical bonding, through spatial medium, *Sec. 7(4)3, part A*, of frequency υ has an equivalent frequency n, e.g. chemical bonding frequencies, *Sec. 7(5)2*, within the related mass media, *Sec. 7(4)3, part D*, e.g. chemical bonding. It has an energy of K_Γ^{-1} time higher than related expandon, or, its contracton conjugate, *Note 2(3)1a, Eq. 2(56),* nominating reverson as force carrier within mass media of *T*-symmetry characteristic, *Sec. 2(3)3;* please refer also to *Sec. 5(16)2a*. In case of a coupled electron of opposite spin in a chemical bonding, the reversons are exchanged between the coupled electrons at a reversible manner. A similar scenario is also taking place within nucleus in the form of exchanging particles nominating gluons as binding force between the related quarks within the nuclei. Reversons play analogous role in case of gluons in nuclei from viewpoint of H particle-paths hypothesis. Reversons during each of its transfer from electron e_1 to e_2, or, e_2 to e_1 at stay time intervals ΔT, *Sec. 7(4)2f, part A*, change the spin handedness of each of the coupled electron, as in *Fig. 7(1).* This process can be regarded as an example of H particle-paths motion, *Sec. 7(4)4,* within mass medium, *Sec. 7(4)3, part D*. As a result, the force is carrying within mass medium through particles of zero rest mass of bosonic group and the reversible path-length of SM configuration, *Remark 6(2)1a2*, nominating reverson; please refer also to *Remark 6(1)2*. Factually, the negative square root of *GRT* is related to reverson.

7(5)2- Reverson formation

7(5)2a- General aspect

The energy of reverson in case of a chemical bonding of coupled electron depends on the energy of the chemical bonding in the related medium, e.g. vacuum, gravitational medium. In other words, at ground state the energy of reverson is equal to the cleavage energy of the related chemical bonding. The same argument is also valid for an excited chemical bonding, i.e. the energy of the chemical bonding reverson is equal to the cleavage energy of the bond at exited principal state. Moreover, at each principal state, the reverson during stay time ΔT, *Sec. 7(4)2f, part A*, is changing its H hall package from a type R H hall package or cell of an electron, e.g. e_1, to a type L H hall package of the other electron, e.g. e_2, *Simulation 7(4)3, E2a*, and vice versa, *Remark 7(5)2a1.* Please refer also to *Note 7(4)3, E2c*. Factually, the reverson stay time ΔT inversely is depending on its energy, i.e. hn_0, in one hand, and the media characteristic, i.e. $K_{\Gamma(w)}$, in other hand, *Sec. 7(4)3, E2, Eq. 7(33)6*. In case of an hydrogen molecule, *Sec. 9(3)2*, the H system is constituted of two hydrogen atoms that chemically bonded to each other, a released photon the energy of which is the same as cleavage energy. Thus, in case of hydrogen in molecule according to *Consequence 2(10)1c,* we have:

$$n_H.\Delta T_{H(mass)} = n_p.\Delta T_{p(mass)} = K_m \qquad 7(40)$$

$$\upsilon_H.\Delta T_{H(mass)} = \upsilon_p.\Delta T_{p(mass)} = K_m K_\Gamma \qquad 7(41)$$

In case of a particle, $K_m \cong 1$, *Consequence 2(10)1b*, according to *Eqs. 7(40), 7(41)*:

$$\upsilon_H.\Delta T_{H(mass)} = \upsilon_p.\Delta T_{p(mass)} = K_\Gamma \qquad 7(42)$$

$$\Delta T_p = \upsilon_p^{-1} = n_H^{-1}.\frac{\Delta T_{p(mass)}}{\Delta T_{H(mass)}} = \Delta T_{p(mass)}.K_\Gamma^{-1} \qquad 7(43)$$

Where:

υ_p, υ_H, are the frequency of matter wave, *Sec. 5(6)*, counterpart of photon, and hydrogen molecule

n_p, n_H, are the frequency equivalent number of H particle-paths within photon main body as particle, and hydrogen molecule

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

$\Delta T_{p(mass)}, \Delta T_{H(mass)}$ are internal time intervals of photon, and hydrogen molecule in the related mass medium

ΔT_p, the stay time related to photon as particle, it can be regarded also as stay time of reverson of electrons e_1, e_2, *Simulation 7(4)3, E2a*

Noteworthy, within mass medium, the particle has negative path-length, *Note. 7(5)2a1*, and energy respect to that of vacuum medium. In other words, reverson is transferred in mass medium of SP_l configuration due to the lack of energy contrary to

spatial medium, e.g. vacuum gravitational medium of *SNr* configuration or better to say path-length and energy of opposite signs respect to spatial medium. The lack of energy is equivalent to the lack of H particle-paths, *Note 7(5)2a2*, within the mass medium. It is leading to geometrical, *Sec. 5(16)3b, D*, deformation of arrangement of H particle-paths inner the mass respect to that of the rest state, *Comment 7(5)2a1*, as in the returned energy, E_R, *Sec. 2(2)1, Eq. 2(44),* and *Note 2(2)1b*, and *Note 2(1)4a*. Please refer also to *Proposal 5(16)3b, D1a,* as a similar case of gravitational interactions. Thus, the mass acts as a sink of H particle-paths in this case respect to the rest state.
As a result, through emission of a boson e.g. photon of zero rest mass, to the vacuum medium from an H system e.g. two atoms of hydrogen in hydrogen molecule, is along with equivalent reverson formation within the hydrogen molecule chemical bonding mass medium. The reverson has equal magnitude of energy, and path-length as emitted boson (or photon), but at opposite signs, i.e. negative energy, *Note 7(5)2a2*, and path-length. Please refer also to *Sec. 2(2)1, Eq. 2(48),* and *Sec. 5(7)3.* Therefore, the energy and path-length of the system of interacting atoms remain constant before, and after interaction. In other words, in a closed H system, the total energy and total path-length remain unchanged. Thus, any increment of energy and path-length in a location is along with equal magnitude of energy and path-length decrement in other location based on path-constancy, *Sec. 2(4)1*. Therefore, the closed system obeys the *T*-symmetry. In other means, by time reversal or through striking of the same photon with hydrogen molecule, the chemical bonding is breaking (the coupled electron are separated) and two hydrogen atoms are formed again. In the lift scenario, *Sec. 6(2)2*, two groups of reverson are formed, the first one is entered within the lift mass medium, the second group that are at same energy of the first ones, but at opposite direction are emitted and entered to the mass medium of the Earth based on Mirror Image Effect, *Sec. 6(2)3*. Therefore, according to *Sec. 2(1)1a, Eq. 2(7),* element α, the deviation degree from reversibility at its minus sign can be regarded as a relative extent of reversons formation within mass medium respect to observer *A* at the *CMPRF* origin, *Sec. 8(9)2,* of the whole system.

Example 7(5)2a1- Referring to *Fig. 2(1)*, and according to H particle-paths hypothesis, an isolated mass-body at rest in its equilibrium state can be calibrated as H particle-paths flows that are moving in different directions at a reversible manner without any preference at c speed. Now, supposing the stated above example (or design) is drawn on a sheet of paper in the form of counter-direction parallel straight arrow lines as in *Fig. 2(1)*, (case *A*). When, a peace of the paper is cut from the sheet in such a manner that merely in a straight direction, the co-directions arrow lines are separated from their counter-direction ones, the equilibrium of the rectilinear arrows are broken in any directions on the paper sheet up to reach to a new equilibrium during a rearrangement. Please refer also to *Sec. 5(8)1, Eq. Eq. 5(32)*. At the new equilibrium stage, these rectilinear lines are replacing by related curvilinear ones on a non-plane sheet at either single direction [or common direction, *Sec. 1(3)*] and reversible directions (case *B*). Therefore, the case *A* is related to a mass-body at rest state, the case *B* is related to its motion from viewpoint of the inner motion of H particle-paths. In other words, the hollow in case *A* can be regarded as a simulation of reverson with negative energy and path-length during photon emission. Noteworthy, photon during its propagation is constituted of single direction H particle-paths; while, the emitter molecule (or source) at rest state, e.g. hydrogen molecule chemical bonding, is constituted of reversible counter-direction (or counter-current) H particle-paths along with lack of single direction H particle-paths related to reverson, *Note 5(16)2c, B1*. By a far analogy reverson can be regard as a bubble of air (reverson) in the water (mass medium).

Note 7(5)2a1- The photon emitted from reaction of *2* hydrogen atoms gain a positive path-length of $+h$ value, *Sec. 5(16)3g*; while, the reverson gains negative path-length value $-h$ just during a measurement of photon or hydrogen molecule according to paths-constancy, *Sec. 2(1)2*. Factually, each of hydrogen atoms has a path-length of h value, i.e. $+2h$. The hydrogen molecule and photon individually has path-length value $+h$. Thus:

$$\textit{Hydrogen atom}\ (+h)\ +\ \textit{Hydrogen atom}\ (+h) \rightarrow \text{Hydrogen molecule}(+h) + \text{photon}(+h) \qquad 7(43)1$$

In other words, In *Eq. 7(43)*, the path-length of hydrogen molecule is not $+2h$, but $+h$ due to reverson formation within its chemical bonding of path-length value $-h$ just during a measurement of photon or hydrogen molecule. Moreover, the photon has type R (or L) H hall package; while, the chemical bonding of hydrogen molecule related to reverson has type L (or R) one during any stay time ΔT.

Note 7(5)2a2- The presence of reverson is depended on lacking of H particle-paths of particles (or mass-bodies) respect to their rest state equilibrium, *Sec. 2(1)1a, Fig. 2(1)*. In other words, the arrangement of H particle-paths of a particle is deformed to a new arrangement (or equilibrium) of its H particle-paths along with decrement of the number of H particle-paths the latter respect to the former. As if, some H particle-paths of the mass are removed from its initial rest state in the form of a particle. Thus, the remained geometrical configuration through the rest state of a mass-body can be regarded as a particle of negative energy and path-length, e.g. analogous to cutting a shape in a plane paper sheet, *Example 7(5)2a1*.

Comment 7(5)2a1- The mass at rest state can be regarded as following:

A) A central *G*-reverson, *Sec. 7(5)3b*, at its center of mass; please refer to *Sec. 5(16)2a*.

B) Respect to the origin of a spherical reference frame at the center of mass (or *G*-reverson) of a mass-body, at each point of the related mass, and at any direction, there is a counter-current motion (or flow) of H particle-paths. It can be analyzed as components of radial, and tangential directions; please refer also to *Sec. 5(16)1b, paragraph 3*.

Factually, the *G*-reverson in a normal matter mass medium of a mass-body can be considered as a lack of H particle-paths of SN_r configuration respect to initial SM one, *Sec. 5(15)2b, Diagram 5(1),* since the big bang era. According to *Sec. 5(8)1, Eq. 5(31),* the *G*-reverson depends directly to the gravitational constant G. Please refer also to *Sec. 7(4)3, part J.*

Remark 7(5)2a1- The reverson may be increased adiabatically during evolution time T, based on adiabatic theorem. "The quantum adiabatic algorithm may give us similar results, contingent upon the existence of an energy gap that decreases polynomially with the input"[600] What is *Quantum* in Quantum Computing? "According to the adiabatic theorem (e.g., Messiah 1961) and given certain specific conditions, a quantum system remains in its lowest energy state, known as the ground state, along an adiabatic transformation in which the system is deformed slowly and smoothly from an initial Hamiltonian to a final Hamiltonian (as an illustration, think of moving a baby who is sleeping in a cradle from the living room to the bedroom. If the transition is done slowly and smoothly enough, and if the baby is a sound sleeper, then it will remain asleep during the whole transition). The most important condition in this theorem is the energy gap between the ground state and the next excited state (in our analogy, this gap reflects how sound asleep the baby is). Being inversely proportional to the evolution time *T*, this gap controls the latter. If this gap exists during the entire evolution (i.e., there is no level crossing between the energy states of the system), the theorem dictates that in the adiabatic limit (when $T\rightarrow\infty$) the system will remain in its ground state. In practice, of course, *T* is always finite, but the longer it is, the less likely it is that the system will deviate from its ground state during the time evolution. The crux of the quantum adiabatic algorithm which rests on the adiabatic theorem lies in the possibility of encoding a specific instance of a given decision problem in a certain Hamiltonian (this can be done by capitalizing on the well-known fact that any decision problem can be derived from an optimization problem by incorporating into it a numerical bound as an additional parameter). One then starts the system in a ground state of another Hamiltonian which is easy to construct, and slowly evolves the system in time, deforming it towards the desired Hamiltonian. According to the quantum adiabatic theorem and given the gap condition, the result of such a physical process is another energy ground state that encodes the solution to the desired decision problem. The adiabatic algorithm is thus a rather 'laid back' algorithm: one needs only to start the system in its ground state, deform it adiabatically, and measure its final ground state in order to retrieve the desired result"[600] *Adiabatic Algorithms*. This statement depends upon the entrance of the new systems as input. "The answer differs, of course, according to the particular model at hand. In the adiabatic model, for example, one needs only to estimate the energy gap behavior and its relation to the input size (encoded in the number of degrees of freedom of the Hamiltonian of the system)" [600] *What is Quantum in Quantum Computing?* The stated above energy gap is comparable to the reverson and its interchangeability as discussed above based on *HPPH*. According to *Sec. 8(7)2, E5, Schema E5a*, the spatial patch (related to abstract vacuum) of a particle that is elongated up to a cell of n_s, *Sec. 5(1)1,* cells on Schwarzschild surface of the suppermassif black hole can be regarded as particle's reverson, *Sec. 7(5).* According to *Comment 5(15)3d, B1*, this spatial patch within abstract vacuum, *Sec. 5(16)3h*, of reverson can be regarded as subspace in Hilbert space related to a state of the particle. "Another argument in favor of this conjecture is that the Hilbert subspace "visited" during a quantum computational process is, at any moment, a linear space spanned by all of the vectors in the total Hilbert space which have been created by the computational process up to that moment. But this Hilbert subspace is thus a subspace spanned by a polynomial number of vectors and is thus at most a polynomial subspace of the total Hilbert space. A classical simulation of the quantum evolution on a Hilbert space with polynomial number of dimensions (that is, a Hilbert space spanned by a number of basis vectors which is polynomial in the number of qubits involved in the computation), however, can be carried out in a polynomial number of classical computations" [600] *What is* Quantum *in Quantum Computing?* Factually, according to *HPPH, Sec. 8(7)2, part E2*, merely a state of all of the states of a particle is in expanded configuration, *Sec. 8(7)2, part G*; while, the other ones are in contracted forms. According to above discussion, the spatial patch related to the reverson can be regarded as subspace of the total Hilbert space during time interval $\Delta T_{p(e)}$; while, other spatial patches of the particle states are in contracted configuration. Moreover, during expandon emission and contracton releasing the energy gap (or reverson, *Sec. 7(5)*) of the particle is increased during the time.

7(5)2b-During an interaction

A) In microcosm

The electron at rest state has a linear central reverson that related axeon changes successively at stay time intervals ΔT_{0e} its direction, and handedness at equal probability in different directions, i.e. an equilibrium. Therefore, in Compton Experiment, *Sec. 3(1)1*, during strike of photon λ depending on direction and handedness of electron, one of the cases of θ,φ is occurring. Thus, at special case of *Note 7(5)3a2*, i.e. $\theta=0,\varphi=180°$, the reverson of electron in the direction of propagation of photon λ converts to a newly formed combined reverson. The axeon of combined reverson, according to *Fig. 3(3)* of *Sec. 3(1)1* is added to that of the photon λ depending on energies and momentums of individual photon and electron of the whole system. It is along with the reverson related to the exit of impulsion photon λ' in opposite direction of striking photon λ. Noteworthy, the axeon of reverson of the moving stroked electron at v speed changes its handedness successively at stay time intervals ΔT_e. Moreover, the handedness of correlated photon λ' with its emitter (or moving electron) at any stay time intervals $\Delta T_{\lambda'}$ successively changes its axeon's handedness. According to *Note 3(1)1c, Eq. 3(9):*

$\lambda'-\lambda=\dfrac{2h}{m_{0e}c}$, *Note 3(1)1c*

Thus, referring to relationships $E_{0e}\times\Delta T_{0e}=h$, *Eq. 7(25)1* of *Simulation 7(4)2e1*, we have:

$c\Delta T_{\lambda'}-c\Delta T_{\lambda}=2c\Delta T_{0e}$, or

$$\Delta T_{0e}=\frac{\Delta T_{\lambda'}-\Delta T_{\lambda}}{2} \qquad 7(44)$$

The *Eq. 7(44)* can be compared by some analogy to *Eq. 2(114)a* of *Sec. 2(6)4b, part A*, in case of Sagnac Effect of a source on a round table moving at tangential speed of v.

Where:

- $\Delta T_{0e}, \Delta T_e, \Delta T_\lambda, T_{\lambda'}$, are stay time intervals of electron at rest state, moving electron, striking photon, and impulsion photon respectively.
- E_{0e}, The total energy of electron at rest state

Therefore, the electron stay time at rest state is equal to the mean of difference of photons λ', λ, *Note 3(1)1c*, stay times irrespective of angles θ, φ. In other words, one of the reversons of type R or L configuration in direction of exiting photon λ' and the same magnitude of its reverson remained in moving electron mass medium. This impulsion reverson is in opposite direction of moving electron reverson. The latter is the vector combination of reverson of electron at rest state and the reverson of striking photon λ in the direction of motion. As a result, in case of a moving electron, we encounter with two kinds of reversons as following:

A) Analogous to case of exited electron in atom, *Sec. 7(4)2b*, the photon λ leaving reverson R_λ within the stroked electron mass medium as in *Eq. 7(20),* i.e. baby H hall package; thus, combined with the electron reverson in the direction of moving electron motion. Moreover, the impulsion photon λ' also forsaking the electron mass medium; thus, leaving reverson $R_{\lambda'}$ in the counter-direction of motion and parallel to striking photon reverson R_λ that is left in electron mass medium. Therefore, the difference of the two reversons $R_\lambda, R_{\lambda'}$ is equal to the two overlapped type $R \,\&\, L$ reversons R_{eR}, R_{eL} of electron at rest state before stroked by photon λ.

B) The two types of configuration of axeon of reversons of moving electron in co-direction e.g. type R (or L), and counter-direction of motion reverson of type L (or R) of moving electron changes successively their handedness respectively at stay time intervals ΔT_e. In fact, during particle travel in spatial medium at any stay time period, the handedness of particle H hall package axeon, e.g. type R (or L) is at opposite handedness of interacted H hall package axeon of the spatial medium, i.e. type L (or R). Therefore, according to *Simulation 7(4)2e1*, a W_R (or W_L) expandon is emitted by particle along with a W_L (or W_R) contracton that is transferred spontaneously to the source of emitting particle and ultimately irreversibly absorbed by related black hole, *Sec. 5(7)8*. Therefore, according to these results and *Sec. 7(4)2f, part A*, the particle travel in a medium is along with its H hall package interaction with that of the medium at any of stay time interval of the particle.

C) In other case of angles θ, φ other than special case, there is vector combination of reverson of striking photon with that of the particle, e.g. electron.

D) According to *Sec. 7(4)2b*, the reverson as a singularity in related particle mass medium, or a mass-body, *Sec.7(5)3b*, is surrounded with the particle's axeon, *Sec. 10(8),* e.g. axeons of photon, and electron at both its moving and rest states; please refer also to *Sec. 7(5)3b*.

E) In case of macro-bodies (or polycells, *Comment 5(2)1d, D1*) due to its infinitesimal stay time respect to the striking photon, the former stay time ΔT_P tends to zero, *Sec. 7(4)2f, part A, Eq. 7(26).* Therefore, according to *Eq. 7(44),* $\Delta T_{\lambda'} \cong \Delta T_\lambda$ (or $\lambda' - \lambda \cong 0, m \to \infty$). In other words, the energy of striking photon is equal to that of impulsion one. Please refer also in part *B* of this section.

F) According to above discussion, the reverson in the direction of motion is greater than in its counter-direction. However, the stay time of a particle of SP_l configuration, is at slight preference type L spin rather than type R of SN_r one that reveals just during an interaction (or measurement, *Sec. 8(7)2*).

G) The reverson that is left by an emitted photon in hydrogen molecule at the moment of its formation is correlated with reverson of photon particle's main body (nominating *P*-reverson) through common H hall package tunnel, *paragraph H*, perforated from the mass medium up to vacuum spatial medium, *Sec. 8(9)1*. As a result, the photon during it emission acquires its reverson from hydrogen molecule just during formation of the latter from two hydrogen atoms.

H) The expandon cells that are confined in a cone-like cavity, *Sec. 5(2)1d, part D,* of gravitational spheres of a mass-body constitute a central common H hall package tunnel, *Comment 5(16)2a1*, from the apex of their cone on the *G*-reverson of the mass-body up to a gravitational interaction, nominating cavity reverson. Please refer to *Sec. 8(9)1*.

B) In macrocosm

Before a collision, *Sec. 6(2)1a*, of two mass-bodies (or polycells, *Comment 5(2)1d, D1*) at macrocosm besides of concentric *G*-reverson, *Sec. 7(5)3b*, in each of them, there are two reversons at equal magnitude respect to observer A at the origin of their common *CMPRF, Sec. 8(9)2,* in each of the mass-bodies. After collision, the two reversons are correlated between two mass-bodies. Factually, instead of two individual mono-direction reverson, there is a combined reverson that is composed of its *G*-reverson, and mono-direction one in mass medium, *Sec. 7(4)3, part D*, of each of the mass-bodies. Noteworthy, during a collision, according to *Sec. 6(2)1a*, a group of $\Delta N_{\alpha A}$ H particle-paths leaving the mass-body A; thus, the reverson $R_{\alpha A}$ is left in the mass-body A in one hand. In other hand, another group of $\Delta N_{\alpha B}$ H particle-paths leaving the mass-body B, and occupying the $R_{\alpha A}$ in opposite direction of $\Delta N_{\alpha A}$; thus, the reverson $R_{\alpha B}$ is left within the mass medium of the mass-body B that is occupied by $\Delta N_{\alpha A}$ in opposite direction. Factually, the two reversons $R_{\alpha A}, R_{\alpha B}$ tunneled the *G*-reversons of mass-bodies A, B to each other, i.e. a common H hall package tunnel (cavity reverson, *part I, paragraph H*) within mass media A, B in order to transfer spontaneously, *Sec. 7(4)2f, part c*, two groups $\Delta N_{\alpha A}, \Delta N_{\alpha B}$ single direction H particle-paths to mass-

bodies A, B respectively, *item G* of *Sec. 7(5)2b, part I.* According to *Sec. 5(9)3d, part c*, *Fig. 5(5)2*, this kind of transfer can be regarded analogous to contracton transfer within the common H hall package as a virtual (or false) gravity. Therefore, a deformation, *Note 7(5)2a2,* is occurred respect to observer A in counter-direction of group of H particle-paths transfer in each of the two mass-bodies that leading to motion at opposite direction of initial one. This kind of deformation, *Sec. 7(5)2a*, in case of a mass-body respect to its rest state before and after collision can be regarded as mono-direction reverson that changes its direction through each impact (or collision). The mono-direction reverson through a collision contrary to case of *G*-reverson is of reversible kind. Therefore, can be eliminated in the rest state of a mass-body respect to the observer A of its common *CMPRF*.

7(5)3- Reverson characteristics

7(5)3a- General aspect

The positive and negative energy of a boson, e.g. photon in spatial medium**,** and reverson in mass medium respectively, depends on their H particle-paths relative densities respect to that of the related medium. Therefore, photon has positive energy respect to free and gravitating vacuum media of expanding characteristic; while, reverson has negative energy respect to related mass medium, i.e. lack of H particle-paths of reverson respect to that of mass medium of contracting characteristic. According to *Sec. 8(9)2*, there is a correlation of emitted photon in spatial medium, and its reverson conjugate within mass medium of the emitter (or source). Therefore, according to *Simulation 7(4)2e1*, any expandon emitted by the photon, e.g. W_R (or W_L) in spatial medium is accompanied by a P_L (or P_R) contracton conjugate transfer to mass medium. In other means, by energy decrement of photon related to an expandon emission (i.e. ε_w), the energy related to contracton also through its transfer to the reverson is decreased by $\varepsilon_c = \varepsilon_w$ unit. Thus, the path-length, and energy of emitted photon, and its reverson conjugate to be at equal magnitude and opposite signs all over the propagation of photon, i.e. before its detection (or measurement, *Sec. 8(7)2*). However, just during a detection of the emitted photon, the aggregated contractons, *Note 7(5)3a1*, in reverson are also released, and transferred spontaneously through H hall tunnels, *Sec, 5(9)3d, part c,* towards the supermassif black hole of the host galaxies or clusters, *Sec. 5(7)8*. The reverson obtains again its initial negative energy. Therefore, the emitter, e.g. hydrogen molecule, recovers its initial mood again at the moment of photon emission from viewpoint of its total energy contrary to the case of emitted photon that has lost some parts of its energy in the form of expandons and contractons from the time of photon emission. Therefore, the photon is red-shifted; *Sec. 7(4)2e, part B.* Noteworthy, just during a measurement, *Sec. 8(7)2,* (or detection) of the emitted photon (via an interaction, or, by a measuring device), the detector registers the red-shifted photon. In addition, the correlation of photon-reverson (in mass medium) is disconnected. Similarly, the hydrogen molecule interaction leading also to disconnection of photon-*H2* correlation, *Note 7(5)3a2*. In other means, the wave function of photon-hydrogen molecule is collapsed; please refer also to *Sec. 8(6)*. Moreover, the path-length of photon and its emitter, e.g. hydrogen molecule takes their existence of $+h$ and $-h$ values at equal magnitude and opposite signs respectively, *Note 7(5)2a1*. In fact, the former path-length is related to photon emission in spatial medium of expanding characteristic, the latter to reverson formation within mass medium, e.g. hydrogen molecule, of contracting characteristic; please refer also to *Sec. 7(4)3, parts A,D*.

Note 7(5)3a1- According to *Sec. 5(8)1, Eq. 5(31),* by increasing the light speed c, the Schwarzschild radius is decreasing. The contracton due to their superluminal transfer, i.e. $5\times10^{33}c$, can be penetrate within the singularity of a Schwarzschild surface of a mass-body, i.e. its *G*-reverson, *Sec. 7(5)3b*, and aggregated there up to an interaction, *Note 5(16)3f, B1*. Similarly, in case of contracton absorption by supermassive black hole of the host galaxies, *Sec. 5(7)8*, the contractons are aggregated irreversibly within its central *G*-reverson. Therefore, the idea of accumulation of the whole Universe in a tiny volume after Big crunch era, and at the moment of big bang, *Sec. 5(15)3*, becomes plausible.

Note 7(5)3a2- During the correlation of photon-H2, the stay time of photon in one of its P_L (or P_R) configurations is linked to stay time of reverson in each of coupled electron pair through the related type R (or L) orbital (or H hall package) at reversed handedness. Please refer to *Sec. 3(1)1*, in special case of Compton Effect, $\theta = 0, \varphi = 180°$, the electron moving along $x-$axis, and photon λ' due to impulsion in opposite direction of $x-$axis. Based on above discussion, there is a reverson at the same energy magnitude, and path-length within electron's mass medium at opposite direction of leaving photon λ', but at opposite sign. At any stay time ΔT_P, photon λ' changes its spin handedness, i.e. type R (or L) accompanied reversed handedness of moving electron's spin, i.e. type L (or R) successively up to a measurement at a scenario similar to case of photon-H2 system. Please refer also to *Note 7(4)2b1* in case of reverson formation during photon absorption and emission by excited electron in an atom.

7(5)3b- Singularity aspect of reverson

The H hall package of reverson can be regarded as a singularity within mass medium, and of path-length value $-h$. Similarly, the Schwarzschild surface of a mass-body can be considered as a reverson within the mass-body. It changes its handedness successively during stay time ΔT, *Sec. 7(4)2f, part A*. Noteworthy, in this case, contrary to case of coupled electron pair in chemical bonding of hydrogen molecule, the two types of reverson in the above case are coinciding on each other. It is nominating *G*-reverson of concentric character at rest state of a mass-body. The chemical bonding reverson of hydrogen molecule is nominating non-concentric Mirror Image reverson. The total energy of two types $R \,\&\, L$ of reverson in a chemical bonding e.g. Hydrogen molecule, is equal to $-h\upsilon$. This energy at ground state is equal to the cleavage energy of the related chemical bonding; where, υ is the frequency of successive two types $R \,\&\, L$ reverson configuration at time intervals (or stay time) ΔT, i.e. $\upsilon = \Delta T^{-1}$. Moreover, the path-length of each type of reverson is $-h$ value.

As the results:
I) At ground state, the reversons can be regarded as a lock (or singularity, *Sec. 5(16)2a*) that prevents a system from full collapsing (or further contraction), *Comment 7(5)3b1*.
II) Similarly, to case of ground sphere on the Schwarzschild surface of a mass-body, *Sec. 5(16)1b, part A, Fig. 5(8),* any reverson of types $R \& L$ is surrounded by the particle axeon, *Sec. 10(8),* or spin nominating reverax; please refer also to *Sec. 8(2)3*.
III) The reverson similarly to related H hall package tunnel is constituted of abstract vacuum, *Sec. 5(16)3h*. According to *Note 7(5)3a1,* merely the contracton can penetrate the axeon shell of reverson. Therefore, the contractons are transferred through the reverson and its H hall package tunnel spontaneously.
IV) Analogous to reverson in mass medium, its H hall package in spatial medium is also protected by an axeon shield. By this analogy, the ground state of oscillating electron pair in a chemical bonding, the vacuum quantized textures, *Sec. 5(16)3b*, *part A*, the ground state of electromagnetical wave, *Remark 5(16)3c1,* are constituted of reversons that are shielded by their axeons, *Sec. 7(5)3d*. Please refer also to *Sec. 7(4)2f, part E*.
V) The *G*-reverson is the intrinsic characteristic of mass-body, it has an additive characteristic, *Note 7(5)3b1*. In other words, the related *G*-reverson also is divided proportional to the mass magnitude of divided portions, *Sec. 7(5)3c*. According to *Sec. 7(5)2b, items G, H*, the *G*-reverson of divided portions are correlated to each other through H hall package tunnel in spatial medium. Therefore, by no means, the *G*-reversons are eliminated.
Similarly to case of hydrogen molecule, any entrance of *CF*-line, *Sec. 5(2)1*, of external gravitational field of mass-body M leading to rearrangement of the H particle-paths of mass-body m. It is based on this assumption that there is an oscillating motion (or beat, *Sec. 7(5)3d, part D*) inner an isolated mass-body due to exit of any of its gravitational sphere, *Sec. 5(16)2a*. Therefore, any rearrangement or deformation due to lack of H particle-paths in a mass-body at rest state can be attributed to a particle of negative energy and path-length, *Sec. 5(15)3e*. According to above discussion, the *G*-reverson inner mass medium of a mass-body accumulates the contractons up to a gravitational interaction (or measurement, *Sec. 8(7)2*) with other mass-bodies. Noteworthy, the expandon and contractons are particles that related to gravitational aspect of the mass along with time's arrow, *Sec. 5(16)7*, due to spatial expansion, and time's arrow reversal due to mass medium contraction respectively; while, *G*-reverson related to inertial aspect of the mass along with *T*-symmetry, *Sec. 2(3)3*. According to definition through transferring of two mass-bodies at infinity to a distance r from each other in order to establish a two orbiting mass-bodies system, the two reversons are taken form within the mass medium of each of the mass-bodies due to this motion. In case of a pair of particle, the reverson occupies type R H hall package in one of the particle, the other one occupies type L (or vice versa) at time intervals (or stay time) ΔT successively. Please refer WL to *Sec. 5(16)3b, part B, paragraphs VII, VIII, IX* in case of H hall package singularities in spatial medium. As a result, the H hall packages of spatial medium are linked to each other through a network of H hall package tunnels, *Comment 5(16)2a1*, to the mass-bodies and ultimately to super-massive black holes, *Sec. 5(7)8*.

Note 7(5)3b1- Similarly to case of spatial medium, *Sec. 7(4)3, part A*, the central *G*-reverson in mass medium, *Sec. 7(4)3, part A*, of a mass-body is spread all over the mass-body as individual *P*-reversons of electrons, nuclei of its atoms (or molecules). In other words, the correlation between *P*-reversons through common H hall package tunnels, *Sec. 5(9)3d, part C*, within mass medium reveals as a central *G*-reverson, *Simulation 7(4)3, E2a*, based on Schwarzschild deduction, *Sec. 7(5)3c*. Factually, the $PL \& PR$ contractons are steadily transferred in any of cone-like cavity, *Sec. 5(2)1d, part D*, via common H hall tunnels spontaneously, *Sec. 7(4)2f, part c*, to a n_s cell on Schwarzschild surface and penetrate into *G*-reverson. At the same time, their $WR \& WL$ expandons conjugates are transferred steadily through cone-like cavity in opposite direction and path-lengths towards the spatial medium at c speed via H hall package textures. It is at slight preference of type WR expandon over WL one through spatial medium along with slight preference of contracton PL over PR one within mass medium at equal irreversible path-lengths respect to that of expandons, *Sec. 5(16)11*. As a result, all over this article the mass means a medium, *Sec. 7(4)3, part D*, irrespective of its individual atoms and molecules, *Sec. 5(6)1, item 1V*.

Comment 7(5)3b1- By this assumption, the electron cannot be regarded as point-like *Comment 4(3)1, B1*. Thus, its self-energy is no longer infinite. Thus, according to *HPPH, Sec. 9(4)6,* the self-energy of electron is finite. "Another problem arose when Lorentz introduced his electron theory; merely, the self-energy of a point electron came out as infinite. But, as early as 1929, it became clear that in quantum mechanics, the self-energy of the electron would be infinite as well"[493].

7(5)3c- Star formation from the microscopic dust particles (H hall packages contraction)
A) General aspect
According to *Note 7(5)3b1*, and considering a mass-body in the form of a sphere of uniform density, the *G*-reverson will be revealed at its center of mass with the same geometrical shape. Now, supposing another mass-body the same as the former one that is attached to it by a contact tangential area. The *G*-reverson of the two mass-bodies are correlated by a tunnel to each other at the same geometrical shape of contracting mass-body at micro-level in the direction of the two mass-bodies axis, i.e. a dumb-bell like *G*-reverson. Therefore, a cylindrical shape mass-body has a cylindrical-like geometrical shape of *G*-reverson in its axis. Noteworthy, to any cell of n_s cells on Schwarzschild surface, *Sec. 5(1)1*, of a mass-body, there is terminated a common H hall package tunnels, *Simulation 8(7)2, E5a.* In other words, the *G*-reverson of a mass-body is correlated with each of n_s H hall package, *Sec. 5(2)1d, part D*, through tunnel. Any common H hall package tunnel is branched to subsidiary common H hall package tunnels that are terminating each to an expandon or, sub-expandon H hall package during expansion process. In case of the microscopic dust particles in non-gravitating spatial medium, *Sec. 7(4)3, part A*, the *G*-reverson of individual dust particles are agglomerated to a mass-body (or star) of a single *G*-reverson (that is constituted of n_s cells) in a reversed process via

common H hall package tunnels. The contraction by gravitational collapse is compensated by particles, e.g. photons, neutrons, release each has a *P*-reverson, *Part B*. In other means, the contraction of H hall packages of microscopic dust particles to n_s ones is compensated by H hall package releasing of emitted particles during gravitational collapsing, *Example 7(5)3c, A1*. "In contrast with the much larger dust particles formed on the surfaces of solid planetary bodies and in Saturn's ring, small dust grains always experience considerable attractive Van der Waals or hydrogen-bonding forces whenever they collide with each other". "The dust agglomerates so formed exhibit interesting morphological, mechanical, and optical properties. Systematic investigation of these can help to understand the cosmic material cycle, the formation of the first solid bodies in the solar system."[508]. "The present models for the origin of the solid planetary bodies in the solar system distinct between two major phases:

1) The aggregation of dust particles and clusters in the solar nebulae driven by low velocity mutual collisions and attractive inter-particle forces as the responsible process for the growth of *Km*-sized objects, and
2) The accretion of planetary cores and planets due to intermediate and high-velocity collisions and gravitational attraction."[509] *Abstract*.

Example 7(5)3c, A1- As an example, the fusion of a deuterium and tritium nuclei form a helium nucleus along with neutron each of an H hall package. In other words, by contraction of two H hall packages to one H hall package, one or more H hall package related to neutron or other particles are released.

B) A proposed mechanism

"Star formation is the process by which dense parts of molecular clouds collapsed into a ball of plasma to form a star". "As it collapses, a molecular cloud breaks into smaller and smaller pieces in a hierarchical manner, until the fragments reach stellar mass. In each of these fragments, the collapsing gas radiates away the energy gained by the release of gravitational potential energy."[510] *Cloud collapse*. According to *Sec. 7(5)3c, part A*, the release of gravitational potential energy is equivalent to expandons H hall packages formation in such phenomenon. Factually, according to HPPH, the H hall packages of two or more particles contracts to a single one in order to reach a single reverson of *P*-reversons of initial reactant particles. It is along with one or more transfer of H hall package of escaping particles of the reaction product, e.g. photon, neutron, to spatial medium. It is similar to a chemical reaction in a medium, e.g. water medium, as following:

$$A+B \leftrightarrow P+D\uparrow \qquad 7(45)$$

In order the equilibrium shifts to the right side of *Eq. 7(45),* i.e. product P formation in water medium, the product D must be exited from water medium to spatial medium in the form of a gas (or exit from the water medium in the form of chemical precipitation). By analogy to this discussion, in order to have product P heavier than each of initial reactants in mass medium, *Sec. 7(4)3, part D,* the product D (or its interaction products by a measuring device) of path-length magnitude $N_D.c\Delta T_D$ must be exited from mass medium to spatial one, *Sec. 7(4)3, part A*, along with positive path-length. Noteworthy, product P has negative path-length of magnitude $N_P.c\Delta T_P$, and the initial reactants A,B have negative path-lengths of magnitude $N_A.c\Delta T_A, N_B.c\Delta T_B$ within mass medium respectively. According to path-constancy, *Sec. 2(1)2,* in two different media we have:

$$-N_A.c\Delta T_A - N_B.c\Delta T_B = -N_P.c\Delta T_P + N_D.c\Delta T_D \qquad 7(46)$$

Where, N_A, N_B, N_P, N_D, are the total number of H particle-paths of objects A,B,P,D, and $\Delta T_A, \Delta T_B, \Delta T_P, \Delta T_D$, are the related time intervals in their H hall packages respectively.

In other means, the ingredients A,B,C of SP_l configuration in mass medium e.g. Star core, is along with ingredient D of SN_r configuration that is escaping from star to spatial medium. Please refer to *Sec. 5(16)11*, according to that the path-length in mass medium is equal to the magnitude of path-length in spatial medium, but at opposite signs. Factually, the ingredient D of positive path-length is related to side reactions (or measurement, *Sec. 8(7)2*) that leading to photon emission and escaping particles of SN_r configuration in spatial medium. It is leading to completeness of reaction *Eq. 7(45)*) towards its right hand side, i.e. completeness of fusion. Noteworthy, the reactants just during the collision (or fusion) can be regarded also as mass medium.

Similarly, in case of fission of a particle to lighter ingredients, the measurement is leading to completeness of fission phenomenon. Therefore, the fission product particles take their normal existence. Noteworthy, in case of entangled pair of particle, the measurement of a particle is along with negative path-length in mass medium of detector or measuring device. It is leading to positive path-length value of other one, i.e. $+h$, *Sec. 5(16)3g,* in spatial medium of equal magnitude path-length and opposite sign of the former one, i.e. $-h$, within mass medium. Therefore, just during the interaction, the particle takes its existence, i.e. completeness, *Consequence 7(5)3c, B1*. Moreover, the attribution of negative sign to path-length value in mass medium, and positive sign to that of spatial one in *Eq. 7(46)* is conventional, *Note 5(16)11a*.

Consequence 7(5)3c, B1- In our matter Universe, the reaction entity in its equilibrium state can be regarded as a unique H system, *Sec. 8(5),* of stay time interval ΔT_r, *Sec. 7(4)2f, part A*, and an expanding characteristic of SN_r configuration through spatial medium. The measurement of one of the ingredients of this entity by a measuring device (or environment) can be viewed as an interaction of the entity by a huge inertia mass-body as detector. This detection imparts a negative path-length, i.e. a contracting type L_c path-length value $-h$ to the measured ingredient or particle in the detector mass medium that is along with equal magnitude of positive path-length to the other ingredients of reaction products in the entity, i.e. an expanding type R_e path-length within spatial medium. It is tending to normal existence of its other ingredients or particles, i.e. completeness of reaction, that is along with apparent wave function collapse of the initial system due to decoherence, *Sec. 8(7)1d*.

7(5)3d- A proposed mechanism of mass submission

A) General aspect

According to *Sec. 5(9)3d, part c*, the common H hall packages tunnels (i.e. an extended reverson that is shielded by axeon) are connecting the reversons of particles and mass-bodies. Thus, they constitute a lattice-like network of reversons that are shielded by related axeon in spatial medium (i.e. reverax, *Sec. 7(5)3b*, *item II*). Analogous to the beads that are connecting through a thread, this has a similarity in modern physics. "The (Higgs) theory hypothesis that a sort of lattice, referred to as the Higgs field, fills the Universe."; "In the Higgs field, a particle through it creates a little bit of distortion--like the crowd around the star at the party-- and that lends mass to the particle."[516]. "According to the theory, a particle acquires mass through its interaction with the Higgs field, which is believed to pervade all of space and has been compared to molasses that sticks to any particle rolling through it. The Higgs field would be carried by Higgs bosons, just as the electromagnetic field is carried by photons"[527]; please refer to *Note 7(5)3d, A1*. According to *Sec. 10(6)*, it is equivalent to submission of an axeon of SP_l configuration of equal path-length of magnitude h (along with its reverson) by the network (or decaying particle), *Comment 7(5)3d, B3*, to a pseudo-particle's shell (of the Higgs boson formed in the decaying particle, nominating decaying combined H system, *Sec.7(5)3d, B1*) of SN_r configuration, but at opposite sign. Thus, imparts a counter-current reversible motion, *Sec. 3(1)2*, of H particle-paths (i.e. an appropriate mass) to the Higgs boson. This newly born non-stable Higgs boson of *SM* configuration, *Sec. 3(1)2, Fig. 3(4)c*, has a stay time interval ΔT, *Sec. 7(4)2f, part A*, based on uncertainty principle or a decay lifetime ΔT, *Proposal 7(5)3d, A1*. By a far analogy, the absorption of a photon by an electron in an atom at its excited state has also a stay time that is decayed again to photon and electron, e.g. at ground state; please refer to *Sec. 7(4)2b*. In other words, the excited electron of increased mass (respect to the same electron at ground state) at the moment of its transition to its non-stable reversed handedness configuration is decayed to photon and electron during its stay time. "The Higgs particles connect with the weak force. Electromagnetism describes particles interacting with photons, the basic units of the electromagnetic field. In a parallel way, the modern theory of weak interaction describe particle (the W and Z particles) interacting with electron, neutrinos, quark another particles.", "In many respects, these particles are similar to photons."[517] *Page 1*. According to above discussion, and similar to *Sec. 7(5)2a*, the virtual W and Z bosons pick up its appropriate axeon from the decaying particle, By analogy the virtual Higgs boson shell of SN_r configuration related to dark matter picks up the appropriate contractons from the aggregated contracton, *Comment 7(5)3d, B3*, of a mass-body. Therefore, appearing as real W and Z particles. According to Higgs theory, the Higgs field giving mass to W and Z bosons, and Higgs boson itself, *Proposal 7(5)3d, A1*. Noteworthy, according to *Sec. 7(5)3c, part B*, there is just at the end of interaction, i.e. completeness of interaction, that a (interacted) particle takes its normal existence.

Proposal 7(5)3d, A1:

1) The some part of *S*-partner of a decaying particle assumed at rest furnished the required amount of energy constituted of H particle-paths of SM configuration to the newly born W boson, *Comment 7(5)3d, B3*. This quantity of H particle-paths (or energy) is returned back (or submitted) at the moment of decay process of W boson to the end-products assumed at rest state as their *S*-partner, *Comment 6(2)6a1*, i.e. reversible H particle-paths of the end-products.

2) The remained part of *S*-partner of the decayed particle is converted to the *S*-partner of mass equivalent of kinetic energy of the end-products at motion. In other words, it is related to single direction H particle-paths of end-products at motion.

"The Higgs boson particle is one quantum component of the theoretical Higgs field. In empty space, the Higgs field has an amplitude different from zero; i.e., a non-zero vacuum expectation value. The existence of this non-zero vacuum expectation plays a fundamental role: it gives mass to every elementary particle, which has mass, including the Higgs boson itself. In particular, the acquisition of a non-zero vacuum expectation value spontaneously breaks electroweak gauge symmetry, which scientists often refer to as the Higgs mechanism"[533] *Theoretical overview.* According to *HPPH*, the mutual interaction of contracton aggregate within *G*-reverson of a particle (related to mass medium, *Sec. 7(4)3, part D*) with particle's *S*-partner in spatial medium (related to normal vacuum, and gravitating one, *Sec. 7(4)3, part A*) giving raise to particle stay time interval ΔT_P, *Sec. 7(4)2f, part A*. This is along with subsequent gravitational sphere emission rate, *Note 6(2)6a1*, and *Sec. 7(5)3d, part D.* It can be simulated to the mass of a particle in spatial medium. In other words, according to *Eqs. 7(26), 7(29)3,* the mass of a particle is inversely proportional to ΔT_P.Noteworthy, according to *Sec. 2(1)4*, the inertia (or mass) of a particle is depending on the relative competitive behavior of its inner reversible H particle-paths respect to the entrance (or exit) of single direction H particle-paths.

Note 7(5)3d, A1- This proposed mechanism is based on the idea that the Higgs hypothetical boson can be verified experimentally.

B) Aggregated contractons

1) The *G*-reverson, *Sec. 7(5)3b,* of the particles or mass-bodies can be considered as square of streets (of common H hall packages). In case of decaying particle, its *G*-reverson absorbs its contracton along with the transmitted contractons by other mass-bodies via H hall package tunnels and subsequent combination with single direction H particle-paths of *S*-partner of decaying particle up to massive *W* or *Z* boson, *Sec. 6(2)6a,* and Higgs boson formation in the decaying combined H system, *Remark 7(5)3d*, *B1*. This system releases a baryon along with *W* or *Z* boson, *Remark 7(5)3d, B2*. The boson also is decayed to end-products, imparts the single direction H particle-paths to the latter, and releases again the aggregated contractons, *Comment 7(5)3d, B1,* in *G*-reversons of end-products that transferred spontaneously, *Sec. 7(4)2f part c*, to central black hole, *Sec. 5(7)8*, via network. It is leading to interruption of contractons from related expandons, i.e. completeness of interaction, *Consequence 7(5)3c, B1*, just during a measurement, *Sec. 8(7)2*, (detection or decay process).

II) The contracton are accumulating in *G*-reverson of a decaying particle in order to reach a critical value, *Note 7(5)3d, B4,* related to decay process, *Comment 7(5)3d, B3*. Different decaying particle have their individual critical time intervals. In case of W boson in β^- decay, this time interval (or lifetime) is equal to its stay time interval. The critical time interval is related to stay time interval through an integer number n as following.

$$\Delta T_{crit} = n\Delta T_{stay} \qquad 7(47)$$

In case of stable particle $n=1$ along with types *R & L* expandon emission in spatial medium, *Simulation 7(4)2e1*; while, in case of W boson $n>1$, accompanied with W boson emitting, *Comment 7(5)3d, B4*.

"In β^- decay, the weak interaction converts a neutron (n) into a proton (p) while emitting an electron (e^-) and an antineutrino.

$$n \rightarrow p + e^+ + \upsilon_e^- \qquad 7(48)$$

A the fundamental level, this is due to conversion of down quark to an up quark by a W^- boson; the W^- boson subsequently decays into an electron and a neutron"[519] *β^- decay*; please refer also to *Sec. 10(4)2a*. According to *Sec. 7(5)3c, part B*, the combined H system, *item I,*, is at an equilibrium stage with its end-products. In other words, there is an equilibrium between down and up quarks conversion at any ΔT_{stay} stay time interval of the combined H system. It is terminating after n cycles of ΔT_{stay} during ΔT_{crit} time interval via W boson decaying. The critical time interval is evaluated from the moment of birth of a free neutron. It can be regarded as evolution time of combined H system, *Note 7(5)3d, B5*. Factually, a particle, e.g. neutron, just during a measurement (or interaction, detection) can takes its normal existence, *Sec. 7(5)3c, part B*, i.e. completeness of reaction.
III) Noteworthy, the aggregated contractons within *G*-reverson has a non-gravitational attracting effect alone; *Note 7(5)3d, B1*. Therefore, it has no effect on the related particle, or mass-body in this regards. Therefore, just during the particle decay, the aggregated contracton pick up an appropriate number of H particle-paths of SN_r configuration as in, *Remark 7(5)3d, B1*. Thus revealed as a massive particle of SM configuration, (boson), similar to the end Big Crunch epoch, i.e. accumulation of Black hole remnants and H particle paths of dark energy in spatial medium in the post big bang era, *Sec. 5(15)3c*. Finally, at the completeness stage, its aggregated contractons are released, and transferred spontaneously to the super massif black hole of the host galaxies, or clusters and absorbed irreversibly, *Sec. 5(7)8*.
IV) Any cycle of stay time in *Eq. 7(47)* is related to variation (or increment) of contractons population number in a particle *P*-reverson, Thus, expansion followed with contraction during a cycle is equivalent to type $R\ \&\ L$ expanding spheres emission, *Sec. 7(5)3d, part D*, of reversed handedness, *Sec. 5(16)1b, part A, paragraph 25*, that is related to:

1) The capacity of particle reverson for acceptance of contracton accumulate (or accumulated contractons), i.e. mass of particle, during a cycle
2) The rate of contracton submission to a reverson that is depending on the H particle-paths densities of the related medium; please refer to *Sec. 7(4)2f, part A*.

V) The *P*-reverson of photons irrespective of their energies has a constant path-limit Γ_d in vacuum medium. Therefore, they have an equal magnitude of contractons during each of their stay time intervals, *Sec. 7(4)2f, part A,* in their *P*-reversons, that is equal analogous to W bosons to their constant critical time, i.e. according to *item II,* $n=1$. Therefore, the photon during its stay time (or critical time) is jiggling (*Simulation 8(7)2, E5a, item23*) from its H hall package to the next reversed handedness one. Because of least possible constant magnitude of contractons in the *P*-reverson of photon, it is leading to highest possible speed of a photon regardless of its energy in a normal vacuum. Please refer also to *Sec. 6(2)6c*.

Note 7(5)3d, B1- Factually, the rest mass of a mass-body is depending on countercurrent motion of its H particle-paths of SN_r and SP_l configurations, *Sec. 3(1)2*, in its both gravitational and inertial aspects; please refer to *Sec. 5(16)1b, part A*, and *Sec. 6* respectively.

Note 7(5)3d, B2-

Note 7(5)3d, B3-

Note 7(5)3d, B4:
1) According to *Sec. 2(2)1, Eq. 2(49),* the internal energy of a moving particle E_{in} is equal to its internal energy at rest state E_0 (or rest energy) by γ^{-1} factor. In other words, the internal energy of a moving particle of v speed is diminished respect to the observer A at the origin of the *CMPRF* of Earth-particle, *Sec. 8(9)2*, as v increased by the coefficient γ^{-1} (or $\sqrt{1-v^2/c^2}$).
Therefore, the aggregated contractons of a particle in its *G*-reverson needs a longer time respect to the same particle at rest state in order to reach the critical value. Thus, according to path-constancy, *Sec. 2(1)1*, we have:

$$E_0 \Delta T_0 = E_{in} \Delta T_{in} = const. \qquad 7(49)$$

Please refer also to *Comment 7(4)2f, A1*.
Where, $\Delta T_0, \Delta T_{in}$, are the internal time intervals in the rest and moving frame respectively. Moreover, $\Delta T_0, \Delta T_{in}$ are proportional to clock tick in the rest and moving frame respectively. "In describing the radioactivity process, we are not speaking about time dilation but rather about time-interval or time average taken by the phenomenon to exit the energetic particle or photon

(life-time)"[541]. "According to special relativity, when a particle is accelerated toward the speed of light, its so-called internal clock will tick slower than for the person watching the particles on their clock. Therefore, it would be expected that it would take longer for the particles to decay. Science experiments in particle accelerators have verified that the half-life increases to the exact amount predicted by special relativity"[539]. "A classic experiment on the time dilation phenomenon was performed by B. Rossi and D. Hall in *1941*"."This experiment (with Mu-Mesons) clearly shows that time dilation can be a very significant effect for clocks that are in high speed relative motion"[540]. The *Eq. 7(49)* is also valid in case of external gravitational field, i.e. a particle in nil gravitational and strong one. Thus, the particle in strong field has a decay rate faster than nil one for the similar reason as stated above.

2) The contractons aggregate of a decaying particle is transferred to a huge inertia mass-body regarded as detector, *Sec. 6(2)6a*, during successive measurements, *Sec. 8(7)2,* (e.g. detection, collision via mediator photons) or alternately say interaction. Therefore, the critical value formation in the decaying system is postponed. In other means, the ΔT_{Crit} is elongated, or, better to say, the time interval between two measurements is shorter than ΔT_{Crit} in normal case. "The **quantum Zeno effect** is a name coined by George Sudarshan and Baidyanath Misra of the University of Texas in 1977 in their analysis of the situation in which an unstable particle, if observed continuously, will never decay. One can nearly freeze the evolution of the system by measuring it frequently enough in its (known) initial state"[548] *Introduction*. "The quantum Zeno Effect is the inhibition of transitions between quantum states by frequent measurements of the state. The inhibition arises because the measurement causes a collapse (reduction) of wave function. If the time between measurements is short enough, the wave function usually collapses back to the initial state"[549] *Abstract*.

Note 7(5)3d, B5- "Because the neutron consists of three quarks, the only possible decay mode without a change of baryon number requires the flavour changing of one of the quarks via the weak nuclear force. The neutron consists of two down quarks with charge −1/3 and one up quark with charge +2/3, and the decay of one of the down quarks into a lighter up quark can be achieved by the emission of a W boson. By this means the neutron decays into a proton (which contains one down and two up quarks), an electron, and an electron antineutrino (antineutrino)"[542] *Stability*; please refer to *Note 10(4)2a*. In our matter Universe, contrary to spatial medium, *Sec. 7(4)3, part A*, that favor the emission of expandons or particle of SN_r configuration, the mass medium, *Sec. 7(4)3, part D*, tends to the formation of particles of SP_l configuration of equal path-length and opposite sign, *Sec. 5(16)11*. Therefore, a down quark with charge $-1/3$ is favored to an up quark with positive charge $+2/3$. In other means, the reversed process in free nucleon, i.e. conversion of up quark to down quark is not allowed as in case of free proton conversion to neutron. Therefore, the aggregated contraction of preferential SP_l configuration at critical level forward the free neutron decay via *W* boson formation within mass medium, *Sec. 7(4)3, part D*, of combined H system, *Sec. 7(5)3d, part B, item I*; please refer also to *Comment 7(5)3d, B3*.

Comment 7(5)3d, B1- "Only one Higgs boson exists within the Standard Model. However there are more complex theories, for example Super Symmetry (SUSY), which predict more than one Higgs boson. If we live in a supersymmetric world (meaning the theory of SUSY is realized), there will be at least five Higgs bosons, two charged and three neutral ones. The three neutral Higgs bosons decay to a large fraction into tau leptons and, depending on how *SUSY* is realized, the decay into tau leptons can be especially favored"[528] *Why Tau Leptons?*. According to H particle-paths hypothesis, the aggregated contractons in a *G*-reverson can be belonged to a charged positive, negative particle, or, neutral particles of $SP_l, SN_r,$ and SM configurations. Therefore, depending on the particle, its contracton aggregate is varied. As example, according to *Sec. 4(6)4*, the contractons related to negatively, and positively chaged particles are nominating negactron, and posictron respctively that differs from the gravitational contractons of neutral particles nominating simply contracton.

Comment 7(5)3d, B2- "The (mini) black hole evaporates into particles of the Standard Model. Its lifetime is very short (of the order of $10^{-26} s$ "[537]. Factually in this case, the mass of the final entity that is made in such manner is very low to become a miniblackhole, but it is stable. Thus, in case of stable particle, it leading to emission of an expanding sphere, and in case of decaying particle (or non stable particle), it leading to lighter particles, *Sec. 7(5)3d, part A*.

Comment 7(5)3d, B3- The time duration that a pseudo-particle shell (virtual boson, *Example 2(7)1*) of SN_r configuration obtains its axeon of SP_l configuration in order to reach its critical value of SM configuration (i.e. the birth of real boson) can be regarded as the boson stay time, or lifetime, $n=1$. There are two possibilities in this case that are relating to two phenomena as following:

1) The pseudo-particle shell pick up its axeon from the aggregated contractons in order togiving birth to real boson (i.e. Higgs Boson).
2) The shell acquire its axeon from a quark, e.g d quark of neutron, in case of decaying particle in order to change its flavor. Thus, givig birth to to real boson (i.e. *W* boson).

The possibility 1 is leading to stay time of a particle (i.e mass beat, *Sec.7(5)3d, part D*) including decaying one; while, the possibility 2 leading to decay of particle. Noteworthy, the degree of handedness D_h, *Note 7(4)3, J1*, of particle is reached to zero at the moment of beat (*possibility* 1*)* and quark flavor changing (*possibility* 2). Note that, the possibility 1 is very incovenient to be accepted by *HPPH* via mediator boson. In fact, the counter-currency motion of H particle-paths of particle in both reversible and single direction mode are addmitted in this regards, *Proposal 7(5)3d, A1*. Moreover, according to *Comment 6(2)6a1,* the *S*-partner or part of it, can plays the role of shell of pseudo-particle in this regards, *Note 10(4)2a*.

Comment 7(5)3d, B4- The W boson lifetime is equal to its stay time, *Sec. 7(4)2f, part A*. Thus, appearing as a short range force carrying particle in weak interaction. Factually, the W boson cannot tolerates the handedness reversal of its newly picked up axeon, and decayed.

Remark 7(5)3d, B1- According to *Sec. 5(9)3d*, the gravitational contractons are accumulating in *G*-reverson of decaying particle up to an interaction (e.g. measurement, collision, detection, decay process). Therefore, forming a bulk of aggregated contractons by a far analogy to a non-stable mini black hole, *Sec. 5(2)1c, part c2,* of SP_l configuration of an appropriate lifetime. The bulk during its collapsed acquired an appropriate amount of H particle-paths of SN_r configuration from the decaying particle, and its *S*-partner, *Comment 6(2)6a1,* in related spatial patch in order to form a final entity, *Comment 7(5)3d, B2*. Thus, particle gain a mass, *part III*; please refer also to *Proposal 7(5)3d, A1*. Therefore, transformed to a boson (e.g. W or Z boson) of SM configuration with a lifetime equal to its stay time interval, *Sec. 7(4)2f, part A*.

Remark 7(5)3d, B2- "All three types have a spin of *1*. The emission of a W^+ or W^- boson either raises or lowers the electric charge of the emitting particle by 1 unit, and alters the spin by 1 unit. At the same time, a W boson can change the generation of the particle, for example changing a strange quark to an up quark. The Z boson cannot change either electric charge nor any other charges (like strangeness, charm, etc.), only spin and momentum, so it never changes the generation or flavor of the particle emitting it"[543] *Basic properties*; please refer also to *Sec. 6(2)5, part B*. According to *Note 10(4)2 a*, the configuration of quarks in a nucleon, e.g. neutron udd quarks, changes via gluon exchange between quarks. In other wods, $u \to d \to u \to \ldots$ changes successively during stay time ΔT, *Sec. 7(4)2f, part A*, via gluons exchange that is leading to successive types $R \,\&\, L$ electromagnetical expandons, *Sec. 4(6)4*, emission; please refer also to *Simulation 7(4)3, E2a*. Noteworthy, during spin variation of a baryonic decaying particle during decay process, the path-length of emitting baryon end-product is also varied by $1\hbar$ unit respect to decayed one.

C) Boson formation

C1) During decay process and mass submission

The two processes of W boson and Higgs boson formation are taking place in decay phenomenon as following:

1) Virtual W boson (or shell) is taking form from *S*-partner, *Comment 6(2)6a1*, that subsequently pick up its axeon from the quark of neutron, *Remark 7(5)3d, B2*. Thus, appears as real particle. It decays according to *Sec. 10(6)* to leptons.
2) Virtual Higgs boson (or shell) is taking form from the *S*-partner that subsequently picks up it axeon from the aggregated contracton, thus becoming a real Higgs boson.

Please refer also to *Remark 7(5)3d, B1*, and *Comment 7(5)3d, B3*. In case of non-decaying stable particle, merely the *item 2* is occurred.

C2) Mechanism of boson formation

According to *Sec. 5(15)2b*, *Diagram 5(1),* the H particle-paths of the Universe was initially at the Big Bang, *Sec. 5(5),* era in the form of SM configuration, *Example 7(5)3d, C2*, related to dark matter with trivial handedness degree D_h, and deviation degree from reversibility α. However, during the Universe evolution, by increment of both $D_h \,\&\, \alpha$, the initial homogeneity of the Universe at the big bang era of low entropy is broken towards increasing inhomogenity. Therefore, the entropy is increasing in spatial medium along with normal matter (or mass) formation of SP_l configuration, *Comment 7(5)3d, C2a,* (nucleosynthesis) related to increasing negentropy within mass medium in one hand. In other hand, the dark energy related to H hall packages of generated expandons of expanding SN_r configuration in spatial medium is appeared at increasing rate that is leading to entropy increment. There is a similarity between the Big Crunch, *Sec. 5(15)3c*, of the Universe, according to that the spatial medium is contracted to small value, along with subsequent big bang according to that the evolution of the Universe begun with the particle decay processes, *Note 7(5)3d, C2a*. In other words, the spatial patches (*S*-patches, *Note 6(2)6a1*) of SN_r configuration around an aggregated contractons of a particle contracts towards the center of mass (of SP_l configuration) of decaying particle in order to reach an entity of SM configuration, *item I*. Thus, it is leading to a combination of $SN_r - SP_l$ configurations of H particle-paths of spatial medium and H particle-paths of mass medium related to contractons aggregate accumulation, and the subsequent bursting of the latter to baryon, and W boson. Moreover, the W boson of SM configuration is decayed further to leptons, *Sec. 10(6)*. In case of stable fundamental particles and non-stable ones, the bursting phenomenon is accompanied by an expansion of the spatial medium after contraction, i.e. a spatial distortion.

Example 7(5)3d, C2a- "Top quarks exist only for an instant before decaying into a bottom quark and a *W* boson, which means those created at the birth of the universe are long gone. However, "at Fermi lab's Tevatron, one of the most powerful collider in the world, collisions between billions of protons and antiprotons yield an occasional top quark. Despite their brief appearances, these top quarks can be detected and characterized by the *D*-Zero and *CDF* experiments"[527]. At the instant of collision of high energy protons, and antiprotons, an entity of Fully SM configuration, *Note 6(2)6b1*, of two collided antiparticles that subsequently decayed to two quark and antiquark along with W^+, W^- bosons. The W bosons' shells, *Sec. 6(2)6a*, are constituted of counter-current reversible H particle-paths of SM configuration; while, bottom quark and antiquark have $SP_l \,\&\, SN_r$

configurations respectively, *Sec. 10(4)1*. Therefore, from viewpoint of H particle-paths hypothesis (*HPPH*) they have appropriated mass and inertia, *Sec. 6(2)5, Part B*.

Note 7(5)3d, C2a- "The time it takes for a neutron to decay, which called the half-life, and the nature of radioactive decay ARE important to understanding how elements were created during the Big-Bang". "For the first time since scientists predicted *60* years ago that light is emitted during radioactive decay, a team of researchers has been able to observe this phenomenon during what is known as neutron decay. The results are reported in the *Dec. 21* issue of the journal Nature"[521]. According to *Sec. 7(5)3c, part B*, among the end-products of a decayed particle, (e.g. in *Eq. 7(48)*) at least an decay product must have expanding type of path-length in spatial medium, *Sec. 7(4)3, part A*. The magnitude of the latter must be equal to algebraic sum of contracting type pf path-length also in spatial medium. In this case photon and antineutrino in spatial medium have expanding type of path-length; while, proton, electron have contracting one.

Comment 7(5)3d, C2a- The *S*-partner, *Comment 6(2)6a1*, have SM with nil handedness degree D_h and differs from the normal matter particle that has SP_l configuration with non zero D_h. Moreover, the particle non-zero D_h is interpreted as particle of rest mass. "In the standard model, at temperatures high enough so that the symmetry is unbroken, all elementary particles except the scalar Higgs boson are massless, Noteworthy based on *HPPH* at high temperature era of the Universe, the elementary particles loses their axeons, *Sec. 10(8)*, i.e. dismantling, *Sec. 10(6),* including quarks; thus, becoming massless. At a critical temperature, the Higgs field spontaneously slides from the point of maximum energy in a randomly chosen direction. Once the symmetry is broken, the gauge boson particles, such as the W bosons and Z boson, acquire masses. The mass can be interpreted as the result of the interactions of the particles with the Higgs ocean"[547] *General discussion*. The concept of mass or inertia, *Sec. 2(1)4*, according to *HPPH* is differ from Higgs. In fact, the former interprets the mechanism of beat of gravitational sphere emission, *Sec. 7(5)3d, Part D*, in case of mass-bodies from view point of *HPPH*.

D) Beat of gravitational sphere emission

During any outwards beat within mass medium from the Schwarzschild surface (or *G*-reverson), *Sec. 5(16)2a*, towards spatial medium is accompanied by a subsequent inward beat at a reversed process, i.e. along with spatial patches contraction around the particle*, Note 7(5)3d, D1,* and *Simulation 8(7)2, E5a, paragraphs 17, 19*. It is performed in such a manner that the algebraic sum is equal to the preference of expansion over contraction in spatial medium, a preference of mass medium contraction over its expansion at equal path-length and opposite sign; please refer also to *Sec. 5(15)3c*, and *Note 6(2)6a1*. Noteworthy, any outwarding and inwarding beat time interval is equal to stay time interval, *Sec. 7(4)2f, part A*, in types $R\,\&\,L$ H hall packages (or axeons) of a particle, *Simulation, 7(4)2e1*. Please refer also to *Sec. 7(5)3d, Part B*, *item IV,* and *Consequence 7(4)2ea*. Factually, the outwarding and inwarding beat time intervals (related to types *R&L* H hall package configurations) are depending to time and its reversal, i.e. *T*-symmetry, *Sec. 2(3)3*, of reversible characteristic respectively. It is along with time's arrow, *Sec. 5(16)7,* of irreversible characteristic in spatial medium of K_Γ magnitude of time in *T*-symmetry, *Consequence 2(4)4b1*, and *Sec. 5(16)9d, part c*. In case of non decaying stable particles, during any mass beat, *Sec. 5(16)2a*, the aggregated contractons are rearranged during any stay time interval by entrance of $PR\,\&\,PL$ contractons to the supermassif black hole, i.e. an equilibrium, via common H hall package tunnels of the Network. As a result, through a contracton of type PL (or PR) submission to the *G*-reverson, an expandon of type $WRorWL$ is generated in spatial medium, *Simulation 7(4)2e1*; please refer also to *Sec. 7(4)3, parts A, D, Sec. 7(4)4,* and *Comment 7(5)3d*, *C2a*.

Note 7(5)3d, D1- The aggregated contractons in the beat process play the role similar to a catalyst in chemical reactions. In other words, the aggregated contractons of a normal matter acts as an intermediate agent that converts the dark matter, *Sec. 5(1)2* of SM configuration to dark energy (or expandons) of SN_r configuration in spatial medium, *Sec. 7(4)3, parts A*, in one hand. On other hand, the contractons are transferred ultimately to the supermassif black hole of the host galaxies and clusters, *Sec. 5(7)8*. Please refer also to *Sec. 5(15)2b*, *Diagram 5(1)*.

E) Negapa and posipa increment during the Universe evolution

The expandons have right-handed SN_r configuration. Therefore, the negapas are increasing through spatial medium*, Sec. 7(4)3, part A,* during the evolution time, *Sec. 7(4)3, part J*. According to path-constancy, *Sec. 2(1)2,* the contractons have left-handed SP_l configuration. Thus, the posipas are increasing within mass medium, *Sec. 7(4)3, part D*, of equal magnitude of negapas, but at opposite sign. On other hand, the vacuum dark energy density is increased proportional to negapa (or posipa) population increment that is along with total energy density, *Sec. 5(16)3c*, decrement. As the result, the product of negapa density by vacuum energy density has a finite value. According to *Note 1(1)1*, and *Sec. 4(3),* the negapa and posipa are the representation of electric charges in a medium. "Ernst Stueckelberg discovered a version of the Higgs mechanism by analyzing the theory of quantum electrodynamics with a massive photon. Stueckelberg's model is a limit of the regular Mexican hat Abelian Higgs model, where the vacuum expectation value H goes to infinity and the charge of the Higgs field goes to zero in such a way that their product stays fixed. The mass of the Higgs boson is proportional to *H*, so the Higgs boson becomes infinitely massive and disappears. The vector meson mass is equal to the product *eH*, and stays finite"[547] *Affine Higgs mechanism*. According to above discussion, through increment of D_h, *Note 7(4)3, J1*, of an H hall package of vacuum medium , the degree of right-handedness of the latter is increased along with decrement of its energy content. Therefore, according to *Sec. 7(5)3d, part C2*, a boson of fixed mass can be generated accordingly.

7(6) - Energy-space-time correlation at quantum level

The uncertainty relationship, *Eqs. 7(5), 7(10),* can be attributed to the nature of energy, space, time, as a single entity, *Remark 7(6)1*, or, in other words, condition imposed by energy, space and time quantization. Remarkably, an H particle-path or group of that is confined in its related H hall quantized packages, *Sec. 5(16)3a,* can be viewed as a quantum entity along with energy-space-time at quantized level. Or, better to say, a defined path-limit Γ, *Sec. 1(12),* which is attributed to an string-like quantized H hall quantized package of path-length value h, *Sec. 5(16)3g*. It can be regarded as a quantum entity that is replacing at c speed, and at its ultimate feature have two forms, e.g., right- (negapa) and left-handed (posipa) H particle-paths. During inflation of the Universe, *Remark 7(6)2,* H hall quantized packages are generated along with its path-lengths; as if, texture of space and time during its expansion is woven continuously with path-length yarn coils, *Note 7(6)1*; please refer also to *Secs. 5(16)3b, 5(16)5.* If any of these three physical quantities increases the two other ones decrease on the basis of uncertainty principle at quantum scale accordingly, i.e. in the framework of H hall quantized packages; please refer to *Sec. 2(6)2a, Remarks 2(6)2; Sec. 5(16)3a, Remark 5(16)3a1,* and *Sec. 5(16)1c, part B.* "We first propose a dual to non-linear realizations of relativity in momentum space, and show that for such a dual the spacetime invariant is an energy-dependent metric"[592] *Abstract*. "We found that cosmological distances, in an expanding universe, become energy dependent. Thus, the physical distance associated with a given commoving distance depends on the energy scale at which it is measured. Seen in another way, the age of the universe is energy dependent"[592] *Conclusions.* According to *HPPH*, the path-limit Γ is depending to H particle-paths densities (or energy densities) in a medium, i.e. energy dependent. It has different values in different medium, e.g. normal vacuum, gravitating vacuum, mass media, *Sec. 5(16)3b, part D2*, and *Sec. 7(4)3, part G*. Path-limit Γ is comparable to energy-dependent space time invariant metric of *DSR, Note 8(1)1b*.

Note 7(6)1- Vacuum can be represented by this texture at its ultimate expansion based upon H particle-paths moving continuously at c speed.

Remark 7(6)1– "Einstein's general theory of relativity posits that gravity, time, and three-dimensional space are woven into a single, universal entity. What we perceive as the force of gravity is really a matter of geometry – a consequence of the curvature for four-dimensional space-time"[269]. From H particle-paths viewpoint, the gravity is formed by H particle-paths arrangement in outer space of a mass (or beyond Schwarzschild surface of mass) due to effect of expanding closed gravitational surfaces. Moreover, to any of these surfaces imparts the related energy; please refer to *Sec. 5(16)1b, part A*.

Remark 7(6)2 - According to [244A]" In cosmology the volume of the expanding Universe plays the role of time parameter. Since volume is quantized in loop gravity, the evolution of the Universe takes place in discrete time intervals. Bojoland has found that an inflationary expansion might have driven by quantum gravitational effects". On the basis of H particle-paths hypothesis, the time's arrow, *Sec. 5(16)7a,* and space generation mainly depends on a gravitational closed surfaces (or spheres) expansion, *Sec. 5(4).*