Part 5

Part 5a- Particles

9 - Hydrogen atom

9(1) - Electron momentum

In each location of an electron H-system, *Sec. 4(3)1, part c, Explanation of, Fig. 4(4),* and *Remark 4(3)1a,* around proton in a Hydrogen atom, one can analysis electron H particle–paths motions, *Sec. 9(4)7,* according to components P_r. (radial) and $P_\perp$ (tangentially, or, perpendicular to P_r) of it's momentum P, *Fig. 9(1)* .

$$p^2 = p_r^2 + p_\perp^2 \qquad 9(1)$$

1) P_r is obtained according to:

$$P_r = \sqrt{2m_{oe}(E + \frac{e^2}{4\pi\varepsilon_o r}) - \frac{l(l+1)}{r^2}h^2} \qquad 9(2)$$

Where; m_{0e} , E , e , l , r are the electron mass, energy , charge , orbital quantum number and radial distance of stated above location from the proton, respectively.

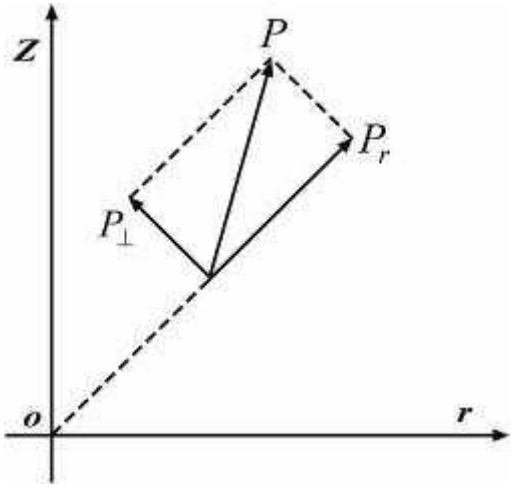

Fig. 9(1) –P *momentum of electron and its components,* P_r, $P_\perp$

According to *WKB* approximation in radial direction for the stationary waves, between two radial boundaries or locations at a, b, we have:

$$2\int_a^b p_r dr = nh \qquad 9(3)$$

n is an integer number that is proportional to the equivalent number of H particle-paths moving radially at c speed in a reversible forward and backward motions, *Eq. 2(57).*

2) According to the following equations.

$$P_\perp = \frac{M}{r} \qquad or \qquad M = rP_\perp \qquad 9(4)$$

M is angular momentum of electron that its z component, M_z is proportional to $\hbar$ by integer number m_l, magnetic quantum number, *Eq. 9(5)*; please refer to *Sec. 9(4).* Moreover, $M = \sqrt{l(l+1)}\hbar$; where, l is the orbital quantum number.

Accordingly, the H particle–paths constituting electrons in an atom can be arranged in m_l groups or orbital with related angular momentums, that can confined in an H hall package, *Sec. 5(16)3a*, of path-length value h. *Sec. 5(16)3g*. Thus:

$$M_z = m_l\hbar \quad , \quad m_l = 0,\pm1,\pm2,....\pm l \quad , \; l = 0,1,2,...,n-1, \quad \textit{Comment 9(1)}l \qquad 9(5)$$

Where, n is the principal quantum number.

Assuming electron's H- system model *Fig. 4(4)*, instead of moving at v speed in an open or straight trajectory, rotate in a closed circuit around it's axis of rotation z, thus we encountered with a distinct L_z momentum around z-axis; please refer to *Fig. 9(3)a* of *Sec. 9(3)a*. In addition, the individual successive motions of H particle-paths along each cell, *Sec. 9(4)7,* are with its own momentum M_c (perpendicular to z-axis). Noteworthy, the direction of M_c altered successively according to uncertainty principle *Eq. 7(5)* an integer of $\hbar$ factor, *Sec. 7(4)2a, Remark 7(4)2a1*. At the atomic scales, supposing the motion of a group of H particle-

paths along overlapped or superimposed cells of its axeon, *Sec. 10(8),* with its own total momentum, we can assume a rough imagination of H particle-paths motions, *Sec. 7(4)4,* of an electron in hydrogen atom. The total angular momentum, *M*, with this assumption can be analyzed to M_z due to common single direction rotational motion of the whole H particle-paths and variable, M_C angular momentum's (at right angle to that) about the proton nucleus related to individual set of H particle–paths cells reversible motion, *Remark 9(1)1*; please refer to *Sec. 1(3).*

According to *Eqs. 9(5),* M_z is related by integer number m_l of $\hbar$ due to motion of H particle-paths in a closed circuit or trajectory that varies with m_l variations, *Remark 9(1)2*, or, in other words, related to exit and entrance of H particle-paths, e.g. of photon, at the electron's orbital, *Sec. 3(2), last paragraph*, *Eq.3(39)* .

According to the assumption of principal state, n, in a hydrogen atom, these groups of H particle–paths distributed between related *S, P,…* orbitals, *Comment 9(1)a,* with their own *M* and M_z angular momentum's in a reversible motion at final c speed respect to an observer o at rest in reference frame *R, Sec. 2(1)1, Fig. 2(1).*

Generally according to the energy differences related to two principal states, i.e. n_i , the initial and n_f , the final one in a hydrogen atom before and after photon absorption $h\upsilon$ (or in case of photon emission) may have :

$$\Delta E = E_i - E_f = \frac{e^4}{2(4\pi\varepsilon_0^2)}\frac{m_e}{h^2}\left(\frac{1}{n_f^2}-\frac{1}{n_i^2}\right) = h\upsilon \text{ , } \textit{Note 9(1)1} \qquad \text{or} \qquad 9(6)$$

$$\upsilon = cR\left(\frac{1}{n_f^2}-\frac{1}{n_i^2}\right) \qquad 9(7)$$

Where, R , called Rydberg constant; please refer also to [169].

According to *Sec. 1, Eqs. 1(1), 1(3); Sec. 4(4), Fig. 4(8), Sec. 4(6)2,* υ is proportional to N_p the number of the H particle – paths entered by photon absorption of hydrogen atom or its exited from that in case of photon emission.

According to the above discussions:

$$h\upsilon = HN_p \qquad or \qquad 9(8)$$

$$N_p = \upsilon / a \qquad 9(9)$$

Note 9(1)1- The transition from a state of higher energy level to a lower one, or vice versa, depends on handedness and reversed handedness of photon's H particle-paths, *Sec. 5(16)9b*, respectively. Due to photon emission from an atom, it is accompanied by path-length increasing of h value, *Sec. 5(16)3g*, related to the emission of the former. Therefore, we encountered with appropriate space expansion and time arrow related to the appearance of H hall package, *Sec. 5(16)3a*, of the emitted photon, and vice versa.

Comment 9(1)1– According to [241], *part related to Bohm's Ontology,* "For the state with principal quantum number *2*, there is a spherically symmetric wave function that look just like *n=1*. However, there are also three other orbitals, (i.e. non-spherical p_x, p_y, p_z), the electrons are moving; thus, accelerating and would be expected to radiate away energy in these *P* orbitals. This is clearly in conflict with the fact that the electrons in the atom do not radiate energy expect when they changes from one allowed orbit to another orbit". Considering H Particle-paths hypothesis, the group of H particle-paths in a *P* orbital can constitute a single electron in it's' track texture, *Sec. 5(16)3b, part B,* that do not radiate energy except when it transferred to another allowed orbital.

Remark 9(1)1– However, if M_z^2 is equal to $\hbar^2 l^2$, i.e. of greatest value, $M^2 = \hbar^2 l^2$, then for the remaining projections there would remain an identical zero. The other projection cannot have any definite values, including zero values, at the same time as $M_z \neq 0$. Therefore, the square of the angular momentum is somewhat greater than the square of the maximum value of any of its projections", i.e. $M^2 = l(l+1)\hbar^2$ [36], *section 30, P. 321*. From viewpoint of H particle-paths due to counter-currency of matter and antimatter Universes (bi-Universes hypothesis), *Sec. 5(16)9,* the projections M_x, M_y of angular momentum have equal probability to be positive or negative with slight preference of the former at each instant in an H hall package of h value, i.e. indeterminacy, *Sec. 8(9)3,* and *Sec. 9(4)7 item 17* . For this reason "One of the angular-momentum projection can always exist together with the square of the total angular momentum" [36], *Section 32, P339*. In other words, M^2 is independent of the sign of angular momentum, *M*, projections.

Remark 9(1)2:

A) Noteworthy, the value of path-length unit h in case of open-ended H system, e.g., free moving electron, or, in case of close-ended H system, e.g., electron in atomic orbit, is an indivisible entity, e.g. as parts of h unit, *Sec. 8(2)3.* Moreover, to each of it, we can attribute an individual quantum state. In other words, h imposed a restriction as lowest possible value of path-length for a whole H system; please refer to *Sec. 9(4), Remark 9(4)1a*. Noteworthy, to each excited state in an atom we can attribute a path-length of h value, *Sec. 7(4)2b.* Factually, according to *Sec. 8(7)2, part E2*, merely a state of the whole states of an

electron is in expanded form; while, other states are in contracted configuration during a stay time interval ΔT , *Sec. 8(7)2, part G.*

B) "An electron in the lowest orbital has an angular momentum equal to $\hbar$. Each orbit after the initial orbit must provides for an electron angular momentum being an integer multiple of that lowest value" [370], *Bohr atom*. According to H particle-paths hypothesis, in the above case the total path-length value, *Sec. 5(16)3*g, of the electron remain unchanged, i.e. h, irrespective of magnitude of its angular momentum.

9(2) – Electron spin in an orbital

During exchange process, in an orbital related to an electron pair *A, B,* some of the H particle – paths of electron *A* exit and transfer to electron B and participate as H particle–paths of the latter *Fig. 9(2);* and return back in the electron *A,* H system; please refer to *Simulation 7(4)3, E2a*. Similarly, the same process occurs for electron *B* in a reversible back and forth motion of H particle–paths between the two electrons *A, B* of the orbital with two parallel one–half spins at opposite directions, (e.g. covalent chemical bonding formation between two atoms of a molecule. Or, the case of pair electrons of an orbital in a single atom), *Note 9(2)1*. Factually, the H particle-paths that are exchanging between the electron pair are transferred non-steadily based on reverson, *Sec. 7(5)*, formation. It is accompanied by electron spin reversal.

Referring to *Fig. 9(2)* there is no participation of H particle- paths between two electrons of parallel spins at same direction for the reason of their impulsive interactions.

The coupling of a pair of electrons at opposite spins in a common or hybrid bonding orbital with their exchanging H particle - paths and participation's is on the basis of Pauli's exclusion principle [170], *Note 9(2)2*.

Supposing two free electrons that repel each other, *Sec. 4(6), Fig. 4(9),* at a long distance can coupled, i.e. with opposite spins, via a short distance near the nucleons, *Note 9(2)3*. Thus, the free moving electrons of two non charged conducting metal plates, (e.g. metallic) in a vacuum can attract each other at thin micro distance (*Casimir Effect* [8]) through mutually exchange of their H particle-paths as discussed above, *Fig. 9(2)*, of free electron s on the outer surfaces of the metal plate. Whereas, *van der Waals*, [305] long range attractive forces, *Note 9(4)6a*, that exist between neutral, but polar atoms and molecules can be attributed to the residual reversible motions of H particle-paths as singlet, *Sec. 1, Note 1(1)1,* through intermolecular of neighboring ones, regardless of intra-molecular interactions related to the molecular structure. Please refer to *Note 9(2)4*. Moreover, the molecules (e.g. gas molecules) exert forces during collision, *Sec. 6(2)1a*, on each other that are related to the exchange of single direction H particle-paths*, Sec. 6(2)3,* between molecules (or molecules and the walls of the containing vessel, e.g., in case of the gas). The stated above forces are apart from the gravitational forces through the whole matter, *Sec. 5*; please refer also to *Sec. 6(2)6*. In fact, vacuum zero point fluctuation, *ZPF* (or zero point energy, *ZPE*, density) can be attributed to freely or randomly moving H particle-paths through free space. According to [85], *ZPE* density is equal to *220 erg/cc* in optical region.

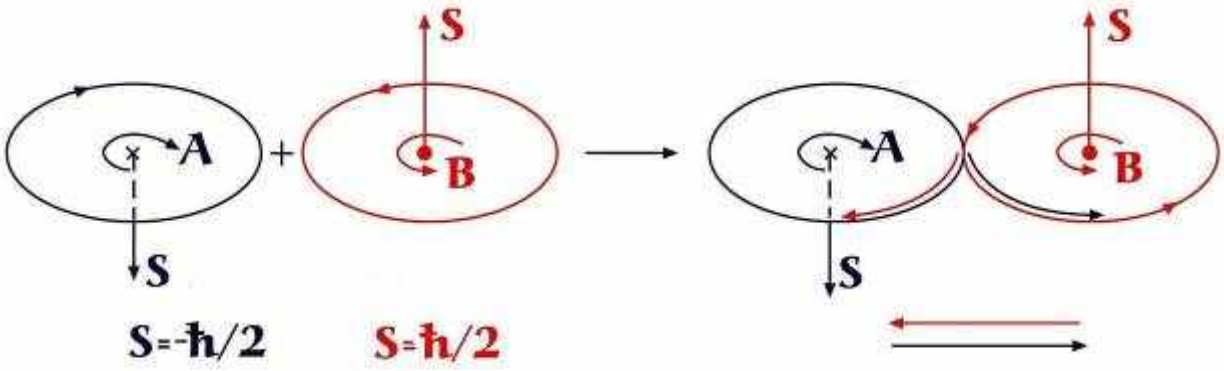

Fig. 9(2) particle - paths exchange between two adjacent cells of a pair of electrons of opposite spins in a occupied orbital.

Note 9(2)1– For the reason of coulomb's interaction between nucleus and bonding electrons in atoms, *Sec. 4(5),* and, *Fig. 4(4),* i.e. coupled *B* vectors of electron and proton*, Sec. 9(3)2*, there is no coulomb interaction at this case,.

Note 9(2)2- A right-handed spin (type *R*) and left-handed spin (type *L*) of free particles are always right-handed and left-handed respectively; so that, one is the mirror image of the other (e.g. electron and positron). Moreover, in a hydrogen molecule two left-handed spin bonded electrons (type *L*) of the initial hydrogen atoms take the anti-parallel, i.e. *CW* (down) and *CCW* (up) spins respect to each other accompanied by the loss of energy *4.47 eV/mole*, according to the Pauli Exclusion Principle. Factually, based on *Simulation 7(4)2e1*, any pair of electron in bounding orbital is reversed spin (type *R* or *L*) of the other one. Therefore, an electron during stay time ΔT , *Sec. 7(4)2f, part A*, through emission of a *P*-expandon e.g. of WL type obtains e.g. type *R* spin (or path-length, *Remark 7(4)3, E2a*). Similarly, the other bonded electron during the same stay time ΔT emits a *P*-expandon of WR type. Thus, acquires type *L* spin, and so on. In other words, two electrons antiparallel spin of the pair during a *P*-expandon emission are interchanged within time intervals (or stay time) ΔT between the two chemically bonded hybrid orbitals. The above process can be regarded as H particle-paths interchanging between two electron-bonding orbitals. Noteworthy, in our matter Universe, there is a slight preference of type *L* spin over type *R* one through the mass medium, i.e. bonding electron's orbital; please refer also to *Simulation 7(4)3, E2a, items 14, 15*.

Note 9(2)3- Electron has a dual characteristic on the basis of its spin, or, in other words, electron in atom has spin 1/2 (fermion) Whereas free moving electron spin in vacuum is *1* (Boson), *Sec. 3(1)1, Note 3(1), paragraph IV, Eq. 3(17)1.* The freely moving electron (non-bonded) of some metals acts as boson at low temperature in the process of superconductivity that obey Bose-Einstein statistic. To express the superconductivity according to *BCS theory* [295]; electron pairs are coupling over a range of hundreds of nanometer, called Cooper pair, these coupled electrons can take the character of a boson and condense into the ground state. "This coupling is viewed as exchange of phonon, phonons being the quanta of lattice vibration energy"[153]. According to [295] "*BCS* theory views superconductivity as a macroscopic quantum mechanical effect. It propose that electrons with opposite spin can become paired, forming Cooper pairs".

Note 9(2)4 – The Casimir Effect [81], Cooper pair [295], Pauli exclusion principle [170], photo-ionization of helium atom [304], have the same origin as shown in *Fig. 9(2),* through mutually exchange of H particle-paths of electron pairs with opposite spin. "Several experimental groups are currently attempting to extend these (distance) limits to $10^{-4} m$, which is near the point where Casimir/ Van der Waals forces overcome gravity to become dominant force between neutral, non-magnetic bodies. This strong intermolecular force background will become a major challenge for experimentalist who attempt to probe gravity at much smaller distances" [473]. According to [295] *introduction*, "*BCS* theory views superconductivity as a macroscopic quantum mechanical effect. It proposes that electrons with opposite spin can become paired, forming Cooper pairs". According to [304], two multi-institutional collaborating, (Max Born institute, Masburg University) in Germany have independently confirmed that electron acts cooperatively when intense light librates two of them from helium and other gas atoms", "Both electrons are emitted in a correlated fashion after the scattering events takes place. Please refer also to *Sec. 5(16)3a, Example 5(16)3a2*, Sec. *8(9), Fig. 8(1).*

9(3)-moving H system
9(3)1- hydrogen atom
9(3)1a - General aspect

I) suppose a free electron moving at $v_e = V$ speed, thus, according to *Eqs. 2(83), 3(9):*

$$\lambda - \lambda' = 2\alpha\, \lambda_e = \frac{2c}{K_\Gamma n_{0e}} = \delta l_e \qquad 9(10)$$

Where, $\lambda_e, n_{0e},$ are the wavelength of moving electron and initial frequency equivalent number of H particle-path of an electron at rest respectively. Moreover, λ, λ', are the wavelength of forwarding and backwarding , *Eq. 2(74),* motions of the related H system (e.g., electron) respectively.

II) At the same manner as (I) for a free moving proton at $v_p = V$ speed:

$$\lambda - \lambda' = 2\alpha\, \lambda_p = \frac{2c}{K_\Gamma n_{0p}} = \delta l_p \qquad 9(11)$$

III) At the same manner as (*I*) for a free moving hydrogen H system:

$$\lambda - \lambda' = 2\alpha\, \lambda_H = \frac{2c}{K_\Gamma n_{0H}} = \delta l_H \qquad 9(12)$$

IV) According to *Eq. 9(10), 9(11)*:

$$n_{0e}\delta l_e = n_{0p}\delta l_p = n_{0H}\delta l_H = 2c / K_\Gamma = \Delta L \qquad 9(13)$$

$$\frac{n_{oe}}{n_{0p}} = \frac{\lambda_p}{\lambda_e} = \frac{\upsilon_e}{\upsilon_p} \qquad 9(14)$$

Since, α , *Eq. 2(7),* as a function of velocity is the same for the three H systems as above.
According to *Eqs. 9(12), 9(14):*

$$\frac{n_{0H}}{n_{0p}} = \frac{\upsilon_H}{\upsilon_p} \qquad 9(15)$$

$$\frac{n_{0H}}{n_{0e}} = \frac{\upsilon_H}{\upsilon_e} \qquad 9(16)$$

Where:

- $\upsilon_e, \upsilon_p, \upsilon_H$, are matter wave frequencies of electron, proton, hydrogen related to their equivalent frequencies n_{0e}, n_{0p}, n_{0H} respectively.

V) Analogous to *Fig. 4(4),* (the proposed model of moving free electron), supposing a model of moving hydrogen atom at v_H velocity and assuming the proton acts as its axeon ,*Sec. 10(8),* along x-axis instead of photonic neutropa cells arrangement, we can deduce the following results:

A) The moving hydrogen H system with a spin $\hbar$ consist of υ_H cells by analogy with the *Sec. 4, Fig. 4(4),* of moving electron

B) At each cell, we have composed B magnetic vectors at opposite direction of posipa and negapa combination related to proton and electron respectively according to *Fig. 4(3),* the *b* and *g* patterns. This coupling balance and completed at hydrogen atom H system ground state, i.e. *B* vectors of equal magnitude, but at opposite direction (the total *B* vectors sum is zero). Please refer also to *Sec. 9(3)a, Fig. 9(3)a*.

To reach this state, the velocities of electron and proton increased (inversely to their related masses, *Sec. 9(3)2, Eq. 9(41)*) respect to their initial velocity *V* in such a rate that, their initial frequencies increase and reach to that of the hydrogen atom at the ground state; please refer also to *Sec. 9(4)4*. Moreover, this is accompanied by photon emission as impulsion of these motions at energy *13.6 eV, Sec. 4(3), Fig. 4(5), Sec. 4(6)2;* thus at the final stage, i.e. ground state we have:

$\upsilon_e = \upsilon_p = \upsilon_H$ *Consequence 9(3)1a1* 9(17)

This means that each of the free negapa of electron is engaged by one posipa of the proton and vice versa in a counter-current mode of motion, *Sec. 3(1)2*, i.e. hydrogen atom axeon, *Sec. 10(8).* Thus, there are no free posipa and negapa as singlet, *Sec. 1(5),* that can continue the electrical attraction i.e. additional attraction of two opposite charged particles ceased at this stage of ground state. Please refer also to *Sec. 9(4)6, and Sec. 9(4)7*, in this regards.

Factually, in the process of hydrogen atom formation from free electron and proton, the photon formation, *Sec. 9(4)7b*, take place during combination of negapa (of electron) and posipa (of proton) accompanied by tangential speed (or frequency) increasing of electron and proton axeons, *Fig. 4(4), Sec. 10(8),* down to that in the ground state *Eq. 9(17).* Moreover, according to *Sec. 4(5), Fig. 4(7)b*, the effect of two opposite charged particles interactions, must be taken under comparative consideration. Please refer to *Sec. 9(4)7b.*

C) According to *Sec.2 (3):*

λ , related to υ_F , *Eq. 2(50),* λ' to υ_B , *Eq. 2(51)*, that are proportional to the wavelength (or frequency) of emitted or absorbed photon respectively, due to the Doppler effect along x-axis and its opposite direction; please refer to *Sec. 4(6)2.*

D) According to *Sec. 3(1)2, Note 3(1)2a,* the spin of hydrogen atom is equal to $\hbar$.

We are encountered with 3 velocities v_e, v_p , v_H in case of hydrogen H system formation as follows, *Note 9(3)1a:*

1) The velocity of hydrogen atom, or, in other words, the external or common velocity of electron and proton, *Sec. 1(3)I.*

2) Internal velocity of electron v_{ein} and proton v_{pin} as following, *Sec. 1(3)II*

$v_{ein} = v_e - v_H$ 9(18)

$v_{pin} = v_p - v_H$ 9(19)

The v_{ein} is much greater than v_{pin} and inversely proportional to their related masses respectively, *Note 9(3)1b.*

Selecting a reference frame *R*' at the same v_H speed as moving hydrogen atom in its axis. Thus the hydrogen atom is at rest in the new reference frame, i.e. v_H is equal to zero. Now, we have a binary H system (hydrogen atom) in it; the moving electron, υ_e and proton, υ_p frequencies are reduced to the internal motion frequencies of electron and proton, i.e. according to the internal speed of electron and proton (case*2*).

According to *Eq. 3(8), 3(10), 9(7)*, in case of ionization of hydrogen atom, i.e. ground state of that, $n_i = 1$, and $n_f \to \infty$:

$$\upsilon_1 = \frac{\upsilon_e}{2\pi} = \frac{K_\Gamma n_{0e}}{2\pi}\alpha_1 = \frac{K_\Gamma n_{\alpha 1}}{2\pi} = cR = \frac{c}{\lambda_1} \quad \text{or} \qquad 9(20)$$

$$\lambda_1 = R^{-1} = 2\pi\lambda_e \qquad 9(21)$$

Where:

υ_1 - Frequency of photon at the case of ionization

λ_1 = Wavelength of photon at ionization case.

υ_e -The matter wave frequency of electron

n_{0_e} -The total initial frequency equivalent number of H particle-paths of electron

α_1 -The returned single direction H particle-paths ratio "deviation degree from reversibility", *Sec. 2(1) , Eq. 2(7)*, related to the ground state.

n_{α_1} -The total frequency equivalent number of returned single direction H particle-paths of electron.

R - Rydberg constant.

K_Γ - The proportionality factor, *Note 2(3)1a*

Thus, the photon frequency is half of the right–handed H particle–paths (negapa) of electron revolution frequency *Eq. 9(20).* By the same analogy, according to *Eq. 9(17)* , the photon frequency is also half of the left-handed H particle-paths (posipa) of proton frequency υ_p , i.e. $2\upsilon_1$.

According to the above statement, proton has equivalent association as electron in the area of photon absorption and emission.

According to *Eq. 4(8), 9(20):*

$$\upsilon_1 = \frac{K_\Gamma n_{o_e}}{2\pi}\left|\frac{\delta e_1}{e}\right| \quad \text{or} \qquad 9(22)$$

$$\frac{\upsilon_e}{K_\Gamma n_{0e}} = \frac{n_{\alpha e}}{n_{0e}} = \left|\frac{\delta_{e1}}{e}\right| = \alpha_1 \qquad 9(23)$$

Where, δ_{e1} is the partial charge, or, better to say, spin behavior effect of single direction H particle-paths, *Sec. 1, Note 1(1)1,* in the ground state.

According to *Eq. 9(20)*, the returned number of the single direction H particle-paths of electron, i.e. $n_{\alpha 1}$ during hydrogen formation or ionization in a $2\pi a_0$ path and time interval dt is equal to 2π times the number of single direction H particle-paths of photon in a path length, cdt, *Sec. 4(6)2, Eqs. 4(24), 4(25)*. Moreover, the path-limit Γ, *Sec. 5(16)3b, part D2*, of electron contracts or wraps, *Notes 1(3), 9(3)1*, i.e. its H particle-paths overlapped on each other to a single wavelength $\lambda_{e1} = 2\pi a_0$; where, a_0 is the radius of the Bohr orbit related to ground state. However, according to constancy of path *Eq. 2(26),* Γ, the total path remain unchanged.

As a result:

$$\begin{bmatrix} circulating.right-handed spin \\ negapa.(type R).of.electron \end{bmatrix} + \begin{bmatrix} circulating..left-handed..spin \\ posipa..(type.L)..of..proton \end{bmatrix} \rightarrow \begin{bmatrix} rectilinear..\sin gle..direction \\ photon..(type.R).or.(type.L) \end{bmatrix} \qquad 9(24)$$

Thus, both electron and proton are engaged in photon emission or absorption process in hydrogen atom, *Sec. 9(3)1b*. Please refer also to *Sec. 9(4)6* in this regards.

Supposing, V_0 the symbolic velocity of electron revolution in the ground state, or, in other words, the common velocity of single direction H particle – paths of that at the ground state; thus:

$$\upsilon_e = V_0 / 2\pi a_0 \qquad 9(25)$$

Where, υ_e, is the frequency of electron revolution, or, better to say tangential common motion of H particle-paths of electron, *Sec. 9(1),* i.e. $P_\perp$.

Moreover, V_0 can be obtained from Bohr Theory as:

$$V_0 = \frac{e^2}{4\pi \varepsilon_o \hbar} = \frac{e^2}{2\varepsilon_0 h} \qquad 9(26)$$

According to *Eqs. 9(20), 9(25), 9(26) :*

$$\upsilon_1 = \frac{K_\Gamma n_{0e}}{2\pi}\left(\frac{V_0}{c}\right)^2 \qquad 9(27)$$

$$\upsilon_e = K_\Gamma n_{0e}\left(\frac{V_0}{c}\right)^2 = K_\Gamma n_{0e}\alpha_1 = K_\Gamma n_{\alpha 1} = 0.658\times 10^{16} K_\Gamma \qquad 9(28)$$

Therefore, the K_Γ numerical value can be obtained according to *Eq. 9(28)* based on υ_e value.

Where:

$$\alpha_1 = (V_0 / c)^2 \qquad 9(29)$$

Thus, according to *Eq. 9(28),* the time of a complete revolution, T_e, i.e. the Bohr time is obtained as:

$$T_e = \upsilon_e^{-1} = 1.52\times 10^{-16} S = 2\delta\tau \qquad 9(30)$$

That is two times greater than the time interval, $\delta\tau$ *Eq. 5(51),* between two successive gravitational surfaces. In other words, during each revolution of electron two gravitational spheres pass through Bohr ground state orbit.

Thus according to *Eqs. 9(20), 9(22), 9(26),* we have:

$$\alpha_1 = \left|\frac{\delta e_1}{e}\right| = \left(\frac{V_0}{c}\right)^2 = \left(\frac{e^2}{4\pi\varepsilon_0 \hbar c}\right)^2 = \alpha^2 = 5.328\times 10^{-5} \qquad 9(31)$$

Thus, α_1 the ratio of partial charge or, in other words, the spin behavior of posipa or negapa flux respect to the total charge , i.e. the partial charge related to unit of charge , is equal to the square of symbolic velocity of electron in the ground state respect to the light velocity ratio. Moreover, α , is the fine structure constant, that its square is a measure of motion of a charged particle, e.g., electron in a electromagnetic radiation field due to the related interaction.

The α_1's *Eq. 2(7)*square (V_0 / c) dependence implies that the single direction H particle – paths instead of moving in a narrow line closed circuit , is spreader on a surface [e.g. sphere, *Note 9(3)1, Sec. 4(6) , Figs. 4(11) to 4(13)*]. Moreover , α_1, is equal to the square of the fine structure constant, α that is serves as a measure of the strength of the electromagnetic interaction based on quantum electrodynamics , *QED.*

Now, defining α_n , as the returned single direction H particle-paths ratio related to the principal state n, according to *Eq. 9(31),* and Bohr's frequency postulate for hydrogen atom , we have:

$$\alpha_n = \frac{\alpha_1}{n^2} = \frac{\alpha^2}{n^2} \quad \text{, please refer to } \textit{Sec. 9(4)4, Remark 9(4)4b} \qquad 9(31)1$$

Thus, α_n is varied by n^{-2} factor of square of fine structure constant, i.e. α^2, what is interesting with fine structure constant comes from the fact that after the splitting , the energy gaps between the new energy levels, *Eq. 9(32),* stemming from the same original level are proportional to α^2, [47]. In other words, to the returned number of single direction H particle-paths, n_{an}, of the principal state; thus:

$n_{an} = n_{0e}\alpha_n$, *Eq. 2(22),* 9(31)2

According to *Eqs. 9(27), 9(28), 9(31); the* energy of principal state, *n,* is obtained as:

$$E_n = \frac{E_1}{n^2} = \alpha^2 n_{0e}\frac{h}{2n^2}\frac{K_\Gamma}{\pi} = \alpha_1 n_{0e}\frac{K_\Gamma h}{2\pi n^2} = \alpha_n n_{0e}\frac{K_\Gamma h}{2\pi} = n_{\alpha 1}\frac{K_\Gamma h}{2n^2} = \upsilon_e\frac{K_\Gamma h}{2\pi n^2} = \upsilon_1\frac{K_\Gamma h}{n^2} \qquad 9(32)$$

Where; E_1, E_n, are nth ground state , principal state energies respectively.

Please refer also to *Sec. 9(4)4*, in case of path-length constancy of electron in hydrogen atom.

Supposing , m_{oe}, m_{op}, are the rest mass of electron and proton in hydrogen atom ; the ratio of coulomb force, F_c, to gravitational force, F_g, is obtained as :

$$\frac{F_c}{F_g} = \frac{\alpha_1}{\alpha_{gr}} = \frac{e^2}{4\pi\varepsilon_o m_{oe} m_{op} G} = \frac{\gamma_e\gamma_p}{\pi\varepsilon_0 G} = \frac{e\mu_B}{\varepsilon_0 m_{op} G h} = -\frac{8\pi^2 e\mu_H}{\varepsilon_o E_{GP} L c} \qquad 9(33)$$

Where:

α_1, α_{gr} : are the ratio of single direction H particle-paths of electron (or proton) in hydrogen atom ground state related to electrostatic and gravitational interaction forces respectively.

Thus, according to *Eq. 9 (28)* ,the fine structure constant, *Eq. 9(31),* is equal to:

$$\alpha = \sqrt{\alpha_1} = \alpha_{gr}\frac{\hbar c}{m_{oe}m_{op}G} = \alpha_{gr}\frac{m_p^2}{m_{oe}m_{op}} = \alpha_{gr}\frac{c^2}{4\pi^2 n_{oe}n_{op}l_p^2} = \alpha_{gr}\frac{l_{ce}l_{cp}}{16\pi^2 l_p^2} = \alpha_{gr}\frac{\delta l_e\,\delta l_p}{16\pi^2 l_p^2}$$

$$= \frac{16\pi^2\mu_B}{e}\times\frac{1}{E_{GP}} = -\frac{8\pi}{L}\times\frac{\mu_H}{e n_{GP}} = -\frac{8\pi}{Le}\times\frac{\mu_H h}{E_{GP}} = \frac{1}{137} = \textit{dimensionless constant}, \textit{Note 9(3)1c} \qquad 9(34)$$

Where,

1) l_p, m_p, n_{oe}, n_{op}, are Planck length, *Sec. 5(8), Eq . 5(33)* , Planck mass, *Eq. 5(34)1,* the total frequencies equivalent number of electron and proton H particle-paths at rest , *Sec . 2(1), Eq . 2(35)*, respectively.

2) μ_H, *L,* are gyromagnetic ratio, hydrogen atom magnetic momentum, and angular momentum of orbiting electron in hydrogen atom respectively.

3) Gyromagnetic ratio (constant) of electron γ_e, and proton γ_p, are obtained as following:

$$\gamma_e = \frac{\mu_B}{\hbar} = \frac{e}{2m_{0e}}, \qquad \gamma_p = \frac{e}{2m_{0p}} \qquad 9(34)1$$

4) E_{GP}, n_{GP} are energy and total number of H particle-path unit, *Eq. 5(1),* in a gravitational sphere of proton respectively.

According to *Sec. 3(1)1* , l_{ce}, l_{cp}, are Compton length related to electron and proton respectively , that are also equal to path differences of their related cell units, *i.e.* $\delta l_e, \delta l_p$, *Sec. 3(1)1, Eq. 3(9)*; moreover, according to *Eq. 9(34),* α_1, α_{gr}, have constant values.

By analogy of the expanding gravitational field sphere, *Sec. 5(4),* we can assume the electrical field potential sphere as expanding sphere that is coincide with the former. Thus, in case of a particle with charge, q, and rest mass, m_o, each of its expanding sphere constitute of n_s H particle-paths, *Sec. 5(1)1,* that N_ε, *Eq. 4(11),* number of that acts as posipa or negapa singlet with a spin interacting behavior coefficient, ε, *Eq. 1(2)1*. Thus, at the case of a fundamental charged particle, i.e. electron, we have:

$$\frac{\varepsilon N_{\varepsilon e}}{a_1 h n_s} = \frac{e}{m_{0e}c^2}\beta \qquad 9(35)$$

Thus, according to *Eqs. 2 (35), 9(35):*

$$\frac{\varepsilon N_{\varepsilon e}}{n_s} = \frac{\beta|e|}{N_{0e}} \qquad 9(36)$$

Thus according to *Eqs. 1(2)1, 5(35), 9(36):*

$$e = \varepsilon N_{\varepsilon e} R_n \beta^{-1} \qquad 9(37)$$

$$N_{\varepsilon e} = \beta N_{0e} R_n^{-1} = \beta K_G n_G = \beta n_s \qquad 9(38)$$

Where:

- n_{0e} is the initial frequency equivalent number of H particle-paths related to the total number of initial H particle-paths N_{0e} of electron of rest mass, m_{0e}.

- β is a proportionality factor of n_s and N_ε (at the case of electron it is $N_{\varepsilon e}$) , or, $N_\varepsilon = \beta\, n_s$.

According to *Eqs. 9(33), 9(36)* at the case of hydrogen atom, α_{gr} , *Eq. 9(34),* is calculated as:

$$\alpha_{gr}=\frac{m_{0e}\,m_{0p}\,G}{\hbar c}\sqrt{\alpha_1}=\frac{n_{oe}\,n_{op}\,N_G\,h^2\alpha}{4\pi\,c^4}\left(\frac{1}{b}\right)=\frac{n_{oe}\,n_{op}}{8\pi\,\varepsilon_o c}\times\frac{\left(\varepsilon\,N_{\varepsilon e}\beta^{-1}\right)^2}{h\,N_G}$$

$$=\frac{n_{oe}\,n_{op}}{8\pi\,\varepsilon_o c^3}\,R_n\left(\frac{\varepsilon\,N_{\varepsilon e}}{\beta}\right)^2=dimensionless\ constant \qquad 9(39)$$

Moreover, according to *Eq. 9(31),* and referring to *Sec. 5(16)1a, Eq. 5(49),* we have:

$$\alpha_{gr}=\frac{m_{0e}\,m_{0p}}{\hbar c}\alpha=m_{0e}\,m_{0p}\frac{A c^2}{4\pi^2}\alpha$$

Where:

- a_1 , constant of media coefficient, *Note 1(2)1.*
- $a_s=1s^{-1}$, *Note 1(2)1,* $b=1kg^{-1}, u=1m^{-1}$ of inverse dimensions based on units of dimensions in *SI* units.
- *A*, correction factor, *A= 0.9262*; please refer to *Sec. 5(16)1a, Remark 5(16)1a3,* and *Sec. 5(16)1c, part A1.*

Consequence 9(3)1a1- Factually, the velocity of electron in ground state, that is related to frequency υ_e , *Eq. (17),* is not confined to hydrogen atom, but the fine structure constant with other method is given the same value for fine structure constant. "A new and wholly different measurement approach using the quantum Hall Effect (*QHE*) has caused excitement because the value of α obtained from it independently corroborate the value α from the electron magnetic moment. It does provide a significant independent confirmation of that value" [388]. Therefore, the dependence of α to velocity of electron in ground state of hydrogen atom, *Sec. 9(3)1, Eq. 9(31)*, implies that in the *QHE* experiment the velocity or frequency of electron is also the same as in hydrogen atom.

9(3)1b- A proposed mode of photon emission or absorption by hydrogen atom

During a photon absorption by an atom, a quasi particle of total energy *E*, and partial negative charge $-\delta e$ (constituted of negapa) according to *Sec. 1(1), Note 1(1)1* is take formed at the excited electron state as following:

$$-\delta e=\frac{\delta\,N_{0e}.e}{N_{0e}} \qquad 9(39)1$$

Please refer also to *Sec. 4(6)2, Eq. 4(27)*, *Sec. 7(4)2b,* and *Sec. 7(4)3, E3*.

This quasi particle has a lifetime ΔT and cell energy ΔE , which obeys the *Eqs. 7(10), 7(17), of Sec. 7(4),* of path-length value nh, *Sec. 5(16)3g, Sec. 7(1), Remark 7(1)3*. Similarly, a quasi particle of positive partial charge $+\delta e$ (constituted of posipa) is formed in the vicinity and around the atomic nucleus with the same lifetime and cell energy. Therefore, during an annihilation process of these two antiparticles photon is reemitted through time interval ΔT .

Where:

- N_{0e} , is total initial H particle-paths (negapa) of electron

"In a hydrogen atom an electron and a proton are bound together by photons. Every photon will spend sometime as a virtual electron plus its antiparticle, the virtual position, since this is allowed by quantum mechanics as described above" [427].

According to *Sec. 4(6)4*, there is a schema of annihilation of charged virtual particle and antiparticle, *Sec. 4(6)5* (or here, quasi particles of opposite signs) through a correlated H hall package between electron and proton in an excited hydrogen atom. The baby H hall package in case of excited electron at the right side of *Eq. 7(20), Sec. 7(4)2b*, that is overlapped with that of proton, plays the role of the stated above correlating H hall package tunneling. Therefore, the generated photon during annihilation process become entangled, *Secs. 8(7), 8(9)1*, with its source, i.e. hydrogen, and propagates at c speed through vacuum texture, Sec. *5(16)3b, part A*.

Note 9(3)1a - Considering, the high density of proton (2.5×10^{11} kg/cm^3) in the minuscule spacing of hydrogen atom (5×10^{-8} cm). Because of extreme density, the gravitational gradient extending from its surface is extreme. The electron H system H particle-paths according to *Secs.5 (10), 5 (11)* will be directed by this extreme gravity gradient into a closed or circular paths [i.e. electron orbital *Secs. 9 (1), 9(2)*], or, in other words, the Γ path-limit, *Note 1(12)2,* wrapped into a closed circular path. Please refer also to *Comment 7(4)1a, part B*.

According to *Eq. 3(10)*, we can have a concept in point of view of an electron surrounding the proton, in which instead of having one dimensional cell (related to matter wavelength) as in *Fig. 4(4).* There will be a superimposed of, υ_e , bi-dimensional cells surface each composed of α^2 ,*Eq. 9(31),* H particle-paths on the sphere related to the ground state of hydrogen atom. Moreover, at this stage the proton can be supposed as axeon, *Sec. 10(8),* of electron H particle-paths.

Note 9(3)1b - The frequencies of electron and proton in hydrogen atom and molecule regarding their masses are proportional to the product of mass and velocity (momentum at low velocity), of common motion of their H particle-paths, *Eq. 2(77).* Moreover at

the case of equal frequencies in hydrogen atom υ_H, *Eq. 9(17)*, and molecule, υ_{H2}, *Eq. 9(40),* regarding the electron and proton masses and speeds, we have:

$$\frac{v_e}{v_p}=\frac{m_p}{m_e} \qquad 9(41)$$

Thus, the relative velocity of electron v_e to proton v_p is related inversely to the ratio of their masses.

According to *Eq. 9(31)*, and *Sec. 2(1)3, Eq. 2(35)*, we have:

$$\frac{v_e}{v_p}=\frac{N_{0p}}{N_{0e}} \quad \text{or} \quad \alpha_p=\frac{v_p}{c}=\frac{v_e}{c}\frac{N_{0e}}{N_{0p}}=\alpha\frac{N_{0e}}{N_{0p}}<1 \qquad 9(41)a$$

Where, N_{0e}, N_{0p}, are the total number of H particle-paths of electron, and proton at rest state respectively. Moreover, we denotes $\frac{v_p}{c}$ as α_p related to proton of hydrogen atom.

Note 9(3)1c, (proposal)- According to V. Flambaun [43] and J. Webb [44] astronomical measurements of the fine structure constant, α ; this particular constant is increasing ever so slightly with time. On the basis of H particle-paths hypothesis, this may be related to the media coefficient a, *Sec. 1(12),* decreasing slightly over history of the cosmos (i.e. time dependence); thus, H hall*, Sec. 5(16)3a,* volume's path-limit, $\Gamma = c/a$, *Eq. 1(3),* increases accordingly. By the way, the light speed, c, is regarded as immutable constant. Considering, *Secs. 5(16)1, Eqs. 5(54) to 5(55)1,* by increasing of the path-limit Γ, the wavelength λ_r, *Eqs. 5(46), 5(47); Fig. 5(8),* and L_G, *Eq.5(55),* increase accordingly; as if at each era of post Big Bang, *Sec. 5(5)11,* a cell proportional to L_G, *Fig. 5(8),* (related to the whole Universe regarded as mass *M*) is attributed to the H hall assumption, *Sec. 5(16)3a*. On the other hand, according to *Eq. 9(34)*, α is equal to the square root of α_1, *Eq. 2(7),* i.e. the ratio of single direction H particle-paths to the reversible one. In other words, the rest mass of fundamental particles in the past are higher than present time that is consistent with, *Sec. 5(1), Eq. 5(6),* the mass loss during the time. This means H halls units accept a defined number of reversible H particle-paths, n_{0e}, *Eq. 3(27)1*, of electron that diminished during the time*, Comment 9(3)1a*. As the result, the generation of gravitational expanding closed surfaces, *Sec. 5(4),* i.e. gravity phenomenon, are related to the ability of H hall acceptance of reversible H particle-paths in the whole Universe; this relate also to vacuum magnetic permeability, μ_0, that depends on 4π value, *Sec. 5(16)4, Note 5(16)12*.

Comment 9(3)1a – Referring to *Sec. 5(16)1a, Eq. 5(49),* by some manipulation of *Eq. 9(34)*, we obtain:

$$\alpha=\sqrt{\alpha_1}=\alpha_{gr}.\frac{\hbar c}{m_{0e}.m_{0p}G}=\alpha_{gr}.\left(\frac{2\pi}{c}(\frac{a_s}{bu})\right)^2.\frac{1}{A.m_{0e}.m_{0p}} \qquad 9(41)1$$

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.
- A is a correction factor, *A=0.9262, Sec. 5(16)1a, Remark 5(16)1a3*.

Therefore, by decreasing, m_{0e}, m_{0p} and considering the light speed c is constant over time, the fine structure constant α increase independent of *G* value accordingly.

Through plugging the dimensionless gravitational coupling constant, α_G, *Comment 9(3)1b*, in *Eq. 9(41)1*, we have:

$$\alpha=\sqrt{\alpha_1}=\frac{\alpha_{gr}}{\alpha_G}.\frac{m_{0p}}{m_{0e}} \qquad 9(41)2$$

According to *Sec. 9(3)2, Note 9(3)1b, Eq. 9(41)a*, and plugging α_p in *Eq. 9(41)2*, we have:

$$\alpha_p=\frac{\alpha_{gr}}{\alpha_G} \quad \text{or} \quad \alpha_{gr}=\alpha_p\alpha_G \qquad 9(41)3$$

Where, α_p, the total number of cells of proton equivalent to α cells in electron. Therefore, α_{gr} related to the single direction (or returned) cells of H particle-paths of electron in case of hydrogen atom (related to gravitational effect of proton (or electron) is equal to the α_p times α_G. In other words, the total number of groups of H particle-paths of electron α_{gr} that is affected by gravitational field of proton in ground state of hydrogen atom.

Comment 9(3)1b - "The gravitational coupling constant is a fundamental physical constant and a coupling constant characterizing the strength of gravitation between typical elementary particle. The defining and the currently known values is:

$$\alpha_G=\frac{G m_{0e}^2}{\hbar c}=\left(\frac{m_{0e}}{M_P}\right)^2=3.217\times10^{-45} \qquad 9(41)4$$

Where:

- M_P, Planck mass, *Eq. 5(34)1*

- m_{0e} the electron rest mass

"α_G is to gravitation what the fundamental structure constant is to electromagnetism and quantum electrodynamics"[387].

9(3)2-Hydrogen molecule

Supposing a hydrogen molecule is formed from two side by side hydrogen atoms, as in the *Sec. 9(3)1*; by analogy with the latter, at this case we are encountered with a common participation in the initial frequency, υ_H, of each of the hydrogen atom during hydrogen molecule formation. Thus, this frequency must be increased to υ_{H2} (of hydrogen molecule).

According to *Sec. 9(3)1,* paragraphs *A&B,* the frequencies of electron υ_e, and proton, υ_P, must be increased from υ_H as in *Eq. 9(17),* to υ_{H2}, at hydrogen molecule ground state i.e. υ_{H2} cells with equal vectors, $\vec{B}$, but at opposite directions, thus:

$$\upsilon_e = \upsilon_P = \upsilon_{H2} \qquad 9(40)$$

Moreover, the frequency increasing accompanied by photon emission. At this stage the H particle-paths of any two adjacent cells (e.g. *A & B* in *Fig. 9(2)*) of a pair of electron at opposite spins exchange reciprocally in order to have a fully reversible motion of their.

9(4)-magnetic dipole moment and angular momentum relationship

9(4)1 – Preliminary steps

The vectors μ, magnetic dipole moment and *M*, angular momentum of an atom, e.g. hydrogen, is related by following equation:

$$\mu = -\frac{e}{2m_{0e}}M \quad , \textit{Comment 9(4)1} \qquad 9(42)$$

and share a common axis [4], *part 4*, *Section*, *51-3-1992*.

From, H particle-paths hypothesis viewpoint, we encountered with a tiny closed loop of circulating H particle-paths of electron as following:

1) A group of H particle-paths moving at counter-currency mode, *Sec. 3(1)2,* in a single direction, α, *Eq. 2(7),* closed circular loop that have linked with the magnitude of mass m_{0e}, *Eq.3(9),* of electron; for more information, please refer to *Secs. 3(2), 4(3),* and explanation of *Fig. 4(4).*

2) A group of H particle-paths as singlet, in case of electron i.e. negapa, at right-handed spin, *Secs. 1(5), 1(14),* moving in a single direction closed circular loop that its magnitude depends on their interaction in a external magnetic field (as another group of field H particle-paths as singlet); moreover, they have linked with the magnitude of electron charge, *e*, *Sec. 4(5).*

As a result, the *M* and μ, *z -axis* components varies quantized by entering, or exit of H particle-paths in its single direction closed (or circular feature). In other words, integer number of $\hbar$ at electromagnetic interaction of a Bohr magneton, μ_B, unit analogous to its open end nature as single direction in a linear motion in space, *Sec. 2(1),* collision, *Sec. 6(2)1a*, i.e. integer number of h.

Finally according to *Sec. 1*, *Eqs. 1(1), 1(3),* The equivalent mass of a group of *N* H particle-paths is equal to NH/c^2, *Sec. 2(1)3*; moreover, it is moving at *c* speed on a circle of radius *r*; thus, according to definition of angular momentum of a purely circular motion, and by analogy to *Note. 3(1)2a, Eq. 3(27),* we have:

$$\overrightarrow{M} = \vec{r} \times \vec{p} = rp = \hbar, \qquad p = mv = \frac{NH}{c^2} \times c, \quad \textit{Comment 9(4)1a} \qquad 9(43)$$

In other words, an H particle-paths (or a group of *N* H particle-paths), *Sec. 9(4)2,* is moving in a closed circuit in an orbital. Therefore, its angular momentum is equal to $\hbar$ as predicted by quantum mechanic, *Remark 9(4)1a*. Thus, at very tiny scale of the quantum level the non-precessing component of total momentum around an axis varied as an integer of $\hbar$. At the above cases, energy varies by *H* quantities; please refer to *Sec. 1(2)*, *Sec. 7(4), Consequence 7(4)1a*, and *Sec. 8(7), Example 8(7)2*.

On the other hand the *z*-component magnetic dipole moment along with related angular momentum are linked separately by the same integer number, m_l, as following:

$$M_Z = m_l \hbar, \quad \mu_Z = -m_l \mu_B \qquad 9(45)$$

Thus, according to *Eq. 9(34)1,* and M_z, μ_z, are related by a constant factor, γ_e:

$$\gamma_e = \frac{\mu_z}{M_z} = \frac{2|\mu_e|}{\hbar} = \frac{e}{2m_e} \cong \frac{\mu_B}{\hbar} \qquad 9(46)$$

Where, γ_e, μ_e, gyromagnetic ratio, the electron magnetic moment, *Note 9(4)1a,* respectively; please refer to *Sec. 9(4)6*.

In fact, a Bohr magneton, μ_B, is magnetic momentum induced by entrance single direction circulating commoving negapa-posipas [neutropas, *Sec.1(5),* as a ring photon], at c speed*, Sec. 4(2), part II, Fig. 4(2);* i.e. through absorption, or exit of an appropriate circulating neutropa through emission.

According to *Note 3(1)2a,* the spin of a free moving electron is $\hbar$. Thus, the intrinsic angular momentum of an electron is related to circular motion of its H particle-paths; *Sec. 9(4)2;* moreover, magnetic momentum (i.e. effect due to motion of H particle-paths as singlet) is related to the latter by gyromagnetic ratio; therefore, circulating H particle-paths have dual characteristics according to its interaction, i.e. electromagnetically and mechanically.

Note 9(4)1a- The gyromagnetic ratio can be considered as affinity (or probability of interaction) to the related interaction of singlet H particle-paths respect to the counter-current one; moreover, e and m are the representatives of H particle-paths interaction in the related singlet forms (electromagnetical), and counter-current forms (mechanical); please refer for additional information to *Sec. 4.* Generally, electromagnetism and mechanic deal on interaction of singlet and counter-current H particle-paths respectively. According to *Note 3(1)2a*, the spin of free moving electron is $\hbar$; thus, the intrinsic angular momentum of an electron is related to circular motion of an H particle-paths; moreover, the intrinsic magnetic momentum (i.e. the effect due to singlet H particle-paths) is related to the latter by gyromagnetic ratio. A circulating H particle-paths singlet has dual characteristics according to its interactions, i.e. electromagnetical and mechanical. Please refer also to *Sec. 5(16)1 b paragraph 13; Sec. 5(16)4.*

Comment 9(4)1a -"The classical variable r, and p cannot have their same meaning in quantum mechanics, and so it should not be surprising that angular momentum takes on a new meaning in quantum mechanics"[4], *Chapter 47-6, the orbital angular momentum*. According to H particle-paths hypothesis, the angular momentum and spin of an particle at microcosm is based on path-constancy, *Sec. 2(1)2*.

Remark 9(4)1a - The quantity of h can be regarded as unit of path-length value, *Sec. 5(16)3g*, in case of closed-end H system (or H hall packages, *Sec. 5(16)3a*) of angular momentum $\hbar$. Noteworthy, h put a restriction to the elements of uncertainty, e.g., position-linear momentum, or, time-energy, *Sec. 7(1), 7(4),* or, angular momentum-angle of rotation in Heisenberg relationships. "From viewpoint of quantum mechanics, any pair of these elements is non-commutative, and do not exits simultaneously in the same state. But, in classical mechanics they exist naturally, but are not conserved" [36], *section 31, P. 326*. In other words, energy and momentum if depend explicitly on time, and position respectively, they do not conserved in classical mechanics. According to *Sec. 2(4),* the path-length values vary by units of h in such cases, which is equivalent to action variation through time, and position that leading to energy and momentum respectively. As a result, according to above statements during an interaction, h unit is the minimum possible variation that in case of massif mass-bodies is negligible due to its huge inertia, *Sec. 2(1)4*, but it is non trivial in case of particle, e.g. photon, electron, *Sec. 7(4)2*. Moreover, the energy, or momentum is transferred through H hall packages, *Sec. 5(16)3a*, of h value, *Sec. 5(16)3g*. Alternately, the participation of multiple H hall packages of h value in an H system covers the non-commutation of elements constituting these H hall packages, e.g., momentum-position, or energy-time. Note that, the angular momentum must be multiplied by angle in order to obtain the path-length of the closed-end H system that is consistent with related uncertainty relation, *Sec. 9(4)2*.

9(4)2 – Discussion

A) In case of a group of *N* H particle-paths, momentum *P* is increased *N* times; whereas, based on *Sec. 7(2),* the segment of circle of radius r is diminished *N* times, i.e. the angle of the segment will be $\Delta\theta = \frac{2\pi}{N}$. Therefore, the magnitude of angular momentum $\overrightarrow{M}$ remained unchanged, i.e. $\hbar$. In other words, the path-limit Γ remained unchanged, *Sec. 7(2).* Therefore, according to *Eq. 9(43),* we have, $\Delta\theta.\Delta M_z \approx h$, that is analogous to the case of $\Delta x, \Delta P_x$, in *Sec. 7(1), Eq. 7(5).* The path-constancy, *Sec. 2(1)2*, in an H hall quantized package, *Sec. 5(16)3a*, of a free moving particle regardless of its mass and velocity [i.e. a group of H particle-paths define the intrinsic angular momentum (spin)] of that particle leading to a constant quantized value, i.e. $\hbar$, *Remark 9(4)1a*. In fact, the emission or absorption process of photon by electron in atoms can be related to quantum H hall packages of h value, or, path-limit, Γ, constancy, *Sec. 3(1), Note 3(1)2a*. According to *Eq. 7(10)* and [166], "the units of h are energy$\times$time. Every photon carries an angular momentum of $\pm\hbar$ "that is the same for a free moving electron according to present article, please refer to *Note 3(1)2a.* From view point of H particle-paths hypothesis, the energy$\times$time and angular momentum$\times$ angle of rotation, of particles, e.g., photon, electron, *Remark 9(4)1a*, are in fact the result of path constancy, Γ, *Sec. 2(1)2,* or in other words, H hall quantized packages (space expansion and time generation), *Secs. 5(16)3,7,* that somehow related to the action and principle of least action, *Sec. 2(4).*

B) In case of principal quantum numbers of $n > 1$, e.g., of a hydrogen atom in its excited state, we encounter with m_l, *Sec. 9(1),* expected independent H hall packages each of path-length value h. Therefore, the z-axis projection of total angular moment *M* of a shell related principal quantum number n varies through this factor, i.e. $M_z = m_l\hbar$, *Sec. 9(1), Eq. 9(5).* In other words, each orbital has its own wave function; moreover, its subsidiary angular momentum z-axis component M_z is equal to $\hbar$, *Eq. 9(43).* Therefore, each orbital coincides with an individual H hall package, *Sec. 5(16)3a,* of path-length value h that can be referred as space quantization.. Note that, according to H particle-paths hypothesis, the H particle-paths of the electron of an hydrogen atom

in excited states constitute m_l individual orbitals that is interpreted as $2l+1$,(or n^2) states, *Sec. 9(4)5*; where l = *1, 2, 3 ,.., n-1* rather than probable existence of electron as a point-like entity; please refer to *Sec. 9(4)5,* in this regards. "These states represent very different probability densities for the electron (as point-like), but they have the same energy" [4] *Chapter 47, part 8,* according to standard quantum theory".

Resuming, based on *Sec. 9(4)5,* and referring to *Se. 9(4)1,* the excited electron in hydrogen atom can be viewed as spatial expansion of bounded electron at rest state. During spatial expansion due to photon absorption each time on of the combined m_l combination, *Sec. 9(4)5*, in an H hall package of path-length value h, *Sec. 5(16)3g*, will be appeared with a total angular momentum of *z*-axis projection $m_l\hbar$ as an algebraic sum of individual z-axis projection of unit of angular momentum $\pm\hbar$ of related orbitals. In other words, each orbital related to an l value, can accepted a *z*-axis projection $+\hbar$, or, $-\hbar$ due to bi-Universes hypothesis Effect, *Sec. 5(16)9*.

9(4)3- A proposed mechanism

As a proposed mechanism, the interaction of the atom and photon during photon absorption takes place in one direction, i.e. the direction of photon absorption. According to Mirror Image Effect, *Sec. 6(2)3*, the excited electron elongated at reversed one-dimensional direction to upper orbit. Therefore, contrary to classical concept, there is no perfect circular motion of electron around the principal orbit. However, there is a cut of a full motion, e.g. circular motion, in the strip of H hall package. It covers both electron, and absorbed photon as one-dimensional quantized space. This space defines the total angular momentum direction respect to the preferred direction, e.g., *z*-axis, due to an external magnetic field. Therefore, this direction in the elongated H hall package has no well-defined (i.e. uncertain) direction due to normal angular momentum projection respect to *z*-axis according to bi-Universes Hypothesis Effect. Thus, the duration of stay time Δt , *Sec. 7(4)2f, part A,* of unstable excited state in the strip of H hall unit obeys the relationship, *Eq. 7(10)* of *Sec. 7(1).* As the result, any m_l combinations, *Sec. 9(4)5*, can be defined by the angle between the two stated above directions.

In the case that, the photon frequency is not appropriate to be absorbed, merely a collision will be taken place between striking photon and atom. Therefore, according to the Mirror Image Effect, the handedness of the photon is reversed; please refer to *Sec. 3(1).*

9(4)4- Path-length constancy of bounded electron in hydrogen atom

Supposing a free electron of velocity $v=0$ [*i.e. rest state,* $\alpha=0$ *, Sec. 2(1)1, Eq. 2(7)]* is interacted with a proton at rest in order to form an hydrogen atom. Referring to *Sec. 2(1)4, Note 2(1)4b*, through photon emission $\alpha<0$. According to Bohr's frequency postulate, the energy, E_n, of stationary states of principal quantum state n of hydrogen atom is equal to $E_n=-\frac{hcR}{n^2}$, $n=1,2,3,...\infty$, *Remark 9(4)4a*. "The energy is negative because the atom is in a bound state; that is, work must be done by some external agent to pull it apart. The potential energy, which is zero at infinite separation of the proton and electron, is negative and larger in magnitude than the kinetic energy" [4] *Chapter 51-1, P. 1071.*

According to path-length constancy, *Sec. 2(1)2, Sec. 2(1)3, Eq. 2(30),* moreover, referring to *Note 1(2)1*, and *Example 2(1)b2*, the partial path-length Δx of electron is obtained as following, *Remark 9(4)4b*:

$$N_{\alpha e}.\frac{H}{a_1 c}.\Delta x = m_{0e}\alpha_n c\Delta x_n = N_p.\frac{H}{a_1 c}.\lambda_n = \upsilon_n\frac{h}{c}\lambda_n = h \qquad 9(47)$$

By manipulation of *Eq. 9(47)*, and *Eq. 9(7)* of *Sec. 9(1),* we have:

$$m_{0e}c\alpha_n\Delta x_n = -hR\lambda_n\left(\frac{1}{m_u^2}-\frac{1}{m_l^2}\right)=h \qquad 9(48)$$

In this special case inserting $m_u=\infty, m_l=n$ in *Eq. 9(48),* therefore we have:

$$m_{0e}c\alpha_n\Delta x_n = hR\lambda_n\frac{1}{n^2}=h \qquad 9(49)$$

According to *Eq. 9(49)*, that is valid for all n principal quantum number, we have:

$$\alpha_n\Delta x_n=\alpha_1\Delta x_1=\frac{h}{m_{0e}c}=\frac{hR\lambda_1}{m_{0e}c} \qquad \text{i.e. } \lambda_1=R^{-1}\text{ , } Eq.\ 9(21) \qquad 9(50)$$

Based on *Eq. 9(50)*, and *Eqs. 9(31), 9(31)1*, we have:

$$\Delta x_n=\frac{\alpha_1}{\alpha_n}\Delta x_1=n^2\Delta x_1 \text{ , } Remark\ 9(4)4b, \qquad 9(51)$$

According to *Eq. 9(50)*, at the case of n = *1*, *Sec. 3(1)1, Note 3(1)1c, Eq. 3(8),* and *Sec. 9(3)1*, *Eqs. 9(21), 9(31):*

$$\Delta x_1=\frac{h}{m_{0e}\alpha_1 c}=\frac{h}{p_{e1}}=\frac{1}{2\pi}\lambda_1=\lambda_{e1} \qquad 9(52)$$

Where, λ_{e1} the electron matter wavelength at ground state. Therefore in path-length constancy relation, *Eq. 9(47),* Δx is the same as the electron matter wavelength, i.e. λ_{e1}

Thus, referring to *Eqs. 9(51), 9(52),* we have:

$$\Delta x_n = \lambda_{en} = n^2 \lambda_{e1} \qquad 9(53)$$

Where, λ_{en} is the matter wavelength of electron in principal quantum state n. therefore, Δx_1, (or λ_{e1}) is the least path-limit of electron in hydrogen atom.

Where:

α_1 - The returned single direction H particle-paths ratio, "deviation degree from reversibility" *Sec. 2(1), Eq. 2(7).*

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

H- Energy associated to an H particle-path, *Sec. 1(2), Eq. 1(1).*

n - Principal quantum number in hydrogen atom

N_p - is the number of H particle-paths of emitted photon's main-body of wavelength λ_n, *Sec. 9(1), Eq. 9(9).*

$N_{\alpha e}$ - Single direction H particle-paths of excited electron, $N_{\alpha e} = \alpha\, N_{0e}$, *Sec. 2(1)1, Eq. 2(22);* is the total particle path of a free electron at rest state N_{0e}

m_{0e} - The mass of electron at rest state

Δx - The partial path-length of excited electron in related H hall package, *Sec. 5(16)3a*; please refer to *Sec. 9(4)3;* moreover, it can be shown in form of Δx_n .related to each principal quantum state n.

υ_n, λ_n – The frequency and wavelength of emitted photon from uppermost energy level $m_u \cong \infty$ to energy level of principal quantum number n, i.e. $m_l = n$, respectively.

R - The Rydberg's constant, $R = \dfrac{m_{0e} z^2 e^4}{8\varepsilon_0^2 h^2 c}$, in case of hydrogen atom $z = 1$.

Noteworthy, the path-limit Δx, at ground state, n =*1*, and second state n =*2,* according to *Eq. 9(53)*, are equal to λ_{e1}, $4\lambda_{e1}$ respectively. In other words, the lower state than ground state *1* is not possible due to limiting condition imposed by minimum electron wavelength λ_{e1} (or path-limit λ , and of h value, *Eq. 9(47)).* Moreover, absorbed photon at state *2* may be split in two parts due to two separate path-limits, i.e. Lyman, Balmer Series respectively.

Through an analogous argument as in *Eq. 9(47),* according to path-length constancy, in case of the proton, we have:

$$N_{\alpha e} \frac{H}{c} \Delta x_{en} = N_{\alpha p} \frac{H}{c} \Delta x_{pn} = h \qquad 9(54)$$

Therefore, according to *Eq. 9(53),* the partial path-length of proton, Δx_{pn}, related to electron partial path-length, Δx_{en}, at principal state n is obtained as following:

$$\Delta x_{pn} = \frac{N_{\alpha e}}{N_{\alpha p}} \cdot \Delta x_{en} = \frac{N_{\alpha e}}{N_{\alpha p}} \cdot n^2 \lambda_{e1} = \frac{n^2}{2\pi} \frac{N_{\alpha e}}{N_{\alpha p}} \lambda_1 \qquad 9(55)$$

Referring to *Sec. 9(3)1, paragraph I, Eq. 9(17)*, at the ground state, the frequencies of electron and proton matter-wave equalized. In other words, in *Eq. 9(55)*, its equivalent values, $N_{\alpha e} = N_{\alpha p}$. Therefore, through considering *Eq. 9(52)*, we have:

$$\Delta x_{pn} = \Delta x_{en} = \frac{n^2}{2\pi} \lambda_1 = n^2 \lambda_{e1} \qquad 9(56)$$

As a result, according to H particle-paths hypothesis, the proton also has the same role as electron of photon emission, or, absorption.

Remark 9(4)4a – According to *Eq. 9(51); Sec. 9(3)1, Eq. 9(31),* the energy, E_n, of stationary state of principal quantum number can be written as following:

$$E_n = -\frac{m_{0e} c^2}{2\pi} \cdot \frac{\alpha^2}{n^2} = -\frac{m_{0e} c^2}{2\pi} \cdot \frac{\alpha_1}{n^2} = -\frac{m_{0e} c^2}{2\pi} \alpha_n = -h\upsilon_n \qquad 9(57)$$

According to *Sec. 2(1)3, Eq. 2(34), 2(35),* we have:

$$E_n = -a_1 N_{0e} \hbar \frac{\alpha^2}{n^2} = n_{0e} \hbar \frac{\alpha^2}{n^2} = -h\upsilon_n \qquad 9(58)$$

Where:

- N_{0e}, the number of H particle-paths of electron, and n_{0e} its frequency equivalent at rest state.
- α, the fine structure constant, *Eq. 9(31).*

Remark 9(4)4b – Factually, each of isolated particle, e.g., photon, electron, proton, etc., has a path-length of h value, *Sec. 5(16)3g*, and path-limit Γ , *Sec. 1(12),* that is confined in an H hall quantized package. Therefore, in *Eq. 9(47)*, the total path-length of

electron is equal to that of related emitted photon in all state of principal quantum number n. Noteworthy, as a result of path-length constancy, [analogous to *Sec. 3(1)2, Note 3(1)2a*, *Eq. 3(24)*] electron and proton each of path-length value h after interaction yield hydrogen and emitted photon that each of them has also a path-length of h value. Thus, in such an interaction in contrast to beta decay, *Sec. 5(16)8*, the total path-length values, i.e. $2h$, remains constant. In other words, no space expansion and time arrow, *Sec. 5(16)7a* generation; please refer also to *Sec. 3(1)2, Note 3(1)8*.

Remark 9(4)4c – Any partial path-limit Δx_n, *Eq. 9(51)*, of total n^2 ones can be related to one of the n^2 sub-shells (or states) of a principal quantum number n. In other words, each sub-shell has its own partial path-limit. Noteworthy, during a measurement (or interaction), *Secs. 8(4), 8(7)2*, hydrogen can be founds in one of its excited n^2 states of path-length value h, *Sec. 5(16)3g*, that is related to an H hall quantized package, *Sec. 5(16)3a*.

9(4)5 – The effect of space quantization and vacuum texture

In case of principal quantum number, $n = 2$, the H particle-paths of the electron constitute four orbitals, one *2s* orbital, ($n = 2$, $l = 0$), and three orbitals *2p* ($n = 2$, $l = 1$). "Three (*2p*) states have the same energy and, for the isolated hydrogen atom, there is no way to separate them experimentally. The hydrogen atom can be found with equal probability in each of three states, so it makes sense to deal with a weighed average probability density for the *2p* state as a whole" [4] *Chapter 47-7*, the *2p state*. As a result, the total angular momentum of electron in principal state $n = 2$ can be supposed as one of the algebraic combinations, (i.e. m_l), of the subsidiary angular momentum of its related orbital each of z-axis projection $\hbar$, i.e. sub-shells (or orbitals) of the principal shell ($n = 2$), that are defined by their orbital quantum number l. In other words, any of this m_l combinations (related to an H hall package) is obtained during a measurement due to the preferred direction induced by placing the hydrogen atom in a magnetic field whose direction defines the z – axis. In the absence of any such preferred direction, the H particle-paths of the electron of excited hydrogen atom can accept randomly, *Sec. 8(7)2, part E4,* all possible m_l combinations as stated above, due to an equilibrium state, *Sec. 1(15)*, without any preference. Moreover, "The restriction on the directions of the total angular vector $\vec{M}$ is called space quantization" [4], *Chapter 47-6, the direction of* $\vec{M}$. This space quantization can be related to the quantization related to existence of H hall quantized package according to H particle-paths hypothesis. Therefore, through increasing n, m_l will be increased, the H hall packages increased accordingly till the classical concept. In other words, by increasing r, the radial distance from the nucleus of hydrogen atom, spatial value, or, total number of H hall quantized packages increases accordingly. According to *Sec. 9(4)4*, the total path-length value relates to n^2 sub-shells is h. Moreover, each of these sub-shells (or orbitals) is associated with a partial path-limit Δx_n (or $\frac{\Gamma}{n^2}$). In other words, there are n^2 orbitals of correlated group of H particle-paths that are confined merely in an individual h hall package (as a unique H system, *Sec. 8(5)*) of n^2 possible ones along with its own angular momentum. It is due to space quantization at the instant of measurement (or interaction), and at the stage of Mirror Image Effect intermediate, *Sec. 8(7)6, part DII*. Noteworthy, both object, i.e. hydrogen atom, and detector, e.g., magnetic field as stated above are initially in equilibrium state in empty vacuum. Therefore, during interaction this equilibrium is broken up to reach to a newer one, i.e. intermediate stage through exchange of related H particle-paths through merely one H hall package. Moreover, the H particle-paths of an object initially in its isolated form can be regarded in an equilibrium state with that of vacuum texture, *Sec. 5(16)3b, part A*. Therefore, an isolated object is a steady interaction –equilibrium at three spatial directions with no preference of selected direction, i.e. z-axis. At each instant, the H particle-paths of electron in hydrogen atom can be found in all of the n^2 orbitals in the absence of measuring device that induced spatial orientation. As a result, the vacuum quantized texture has a main role in quantum mechanical behaviors of particles. Similarly, the vacuum quantized texture is altered somehow by gravitational field texture,. Thus, the motion of particles obey the new texture, i.e. superimposition of vacuum and gravitational field, *Sec. 5(16)1b, part A, paragraph 16.* In case of an external electromagnetical field, e.g., magnetic, or electric field, we encountered with their H particle-paths as singlet, i.e. negapa or posipa, *Sec. 4(1), Note 4(1)1*, that affect the vacuum texture in an selected manner, *Sec. 4(3)1*. In the above discussion, the vacuum texture can be regarded as a sole detector without any preferred direction projection axis, i.e. z-axis. Moreover, in this special case the detector is overlapped on the object. As a result, there are also two concepts of detection (or interaction) that leads to indistinguishability without preferred z-axis, the single direction respect to a preferred (or z-axis). Therefore, the former involved randomly, *Sec. 8(7)2, part E4,* with multiple H hall packages with no distinct direction (indistinguishability), but the latter deals with a successive single mono-dimensional H hall packages. Moreover, in this case, the x, y components, also obey the reversibility (or indistiguishability) concept as in the vacuum case. Consequently, the counter-currency of motion of left-handed and right-handed H particle-paths (reversibility) leading to multiple participation of H hall packages in a phenomenon with no distinct preference, i.e. indistinguishability. Therefore, it is through a measurement that we can assign an attached H hall package to a particle. In addition, the particle changes steadily its associated H hall package with that of vacuum texture through equilibrium. As an example, photon as an single direction H particle-paths moves through vacuum texture successively changes its position in district time intervals, $\Delta T = \left(a_1 N_p\right)^{-1}$, (first case). Moreover, in case of an isolated

particle at rest state, position is changed randomly, *Sec. 8(7)2, part E4,* through distinct time intervals $\Delta T = (a_1 N_0)^{-1}$, (second case). or in general, $\Delta T = (a_1 N)^{-1}$, please refer to *Sec. 7(4)2e*.

Where:

- h, Planck constant.
- N_p, Total number of H particle-paths of photon.
- N_0, the total number of H particle-paths in the system at rest state,
- N, Total number of H particle-paths of a particle.
- a_1, constant of media coefficient, *Note 1(2)1*.

To system of the first case (e.g., photon, as a single direction H system), we can apply a single time evolution. However, in the second case due to full reversibility of the H system internal motion (e.g., many particles system, *Sec. 8(7)6*) at a random manner, there is no distinct time evolution due to indeterminacy or indistinguishability by an outer observer. Moreover, the trajectory of the first case is a distinct single direction. However, the trajectory of the internal motion of second case is indeterminable due to reversibility; please refer to *Sec. 5(16)3, part B*. "Modal interpretations (of quantum mechanics) do admit –trivially- an unreasonable, namely, one in which there is no correlation from one time to the next. (In the case, probability of a transition the property *P* at time t to *P'* at time t' is just the single-time probability for *P'* at t'). In such a case, the book on the table might not remain at rest relative to the table over even if undisturbed" [385] *Dynamics.* According to H particle-paths hypothesis, the fate of a particle in second case is depended on the probabilistic vacuum texture behavior respect to that particle. Factually, the second case, and contrary to macro-body, e.g., book and table, the particle is affected by its random, *Sec. 8(7)2, part E4,* interaction with H particle-paths of vacuum texture, *Sec. 7(4)2f, part A*. However, there is no significant effect of this kind on macro-bodies by vacuum texture. Please refer to *Sec. 5(16)3b, part G*.

Noteworthy, during a photon absorption by hydrogen atom, the following steps take place:

A) The H hall package of the photon of h value, *Sec. 5(16)3g*, is transferred to excited hydrogen atom during photon absorption.

B) A pseudo-unique H system appears at the end of stage *A*, [*Sec. 7(4)2b*, right hand side of *Eq. 7(20)*]. In other words, excited electron (or hydrogen atom) acquires randomly, *Sec. 8(7)2, part E4,* one of the n^2 possible sub-shells (or m_l combinations) at the instant of photon absorption as stated above, *Remark 9(4)4c*.

C) The pseudo H system in stage *B* is a non-stable one that proceeds according to *Sec. 7(4)2b, case IIb*.

9(4)6 - Fine structure constant

"The fine structure constant, α, gives the strength of the electromagnetic interaction, and is a crucial hidden block in our system of fundamental constant"[386].

Considering an electron at rest respect to a proton [i.e. in case of $n = \infty$, *Sec. 9(4)4, Eq. 9(47)*] through reciprocal interaction of these two opposite charges, *Sec. 4(3)*, electron due to its lower mass respect to that of proton, moving relatively towards proton (or center of mass of electron-proton H system). During the electron motion, the deviation degree from reversibility of electron, *Sec. 2(1)1, Eq. 2(7)*, i.e. α_{en}, increased by decreasing the principal quantum number n. Therefore, referring to *Sec. 9(4)4, Eq. 9(47)* in each state related to n. The partial path-length of electron Δx_n is decreased respect to that of ground state, i.e. Δx_1, *Sec. 9(4)4, Eq. 9(51)*. In other words, the path-limit Γ wrapped (or contracted) down to $\Delta x_1 = \lambda_{e1}$, (i.e. de Broglie electron matter wavelength, *Note 9(4)7a*). Through this interaction, a photon is born along with electron from H particle-paths of initial electron-proton H system at rest state, *Sec. 9(4)7*. In other words, $\alpha_{en} < 0$, according to *Sec. 2(1)4, Note 2(1)4b*. At the ground state, $n = 1$, the photon υ_1 is emitted because of path-length constancy, *Sec. 2(1)2*, [or *Sec. 9(4)4, Eq. 9(47)*] from electron-proton H system, i.e. hydrogen atom formation.

"For an arbitrary length *s*, the fine structure constant, α, is the ratio of two energies: (*I*) the energy needed to bring two electrons from infinity to a distant *s* against their electrostatic repulsion, and *(II)* the energy of a single photon of wavelength equal to the same length scaled by 2π (i.e. $2\pi s = \lambda = \frac{c}{\upsilon}$). Where, υ is the frequency of radiation associated with the photon.

$$\alpha = \frac{e^2}{4\pi\varepsilon_0 s} \div h\upsilon = \frac{e^2}{4\pi\varepsilon_0} \div \frac{hc}{2\pi s} = \frac{e^2}{4\pi\varepsilon_0 \hbar c} \qquad 9(58)1$$

"In the theory of quantum electrodynamics, the fine structure constant plays the role of a coupling constant, representing the strength of the interaction between electron and protons. Its value cannot be predicted by the theory, and has to be inserted on experimental results"[379] *Physical interpretation*. According to above statement, assuming the arbitrary distance, $s = \Delta x_1 = \lambda_{e1}$, *Sec. 9(4)4, Eq. 9(52).* Therefore, the photon wavelength can be obtained as following:

$$\lambda = 2\pi s = 2\pi\Delta x_1 = 2\pi\lambda_{e1} = \lambda_1 \qquad 9(59)$$

In other words, in this example the photon wavelength λ_1 is the same as emitted photon, *Sec. 9(4)4, Eq. 9(52).* Thus, fine structure constant is equal to the ratio of the electron-proton H system energy to that of emitted photon λ_1. According to *Sec. 9(3)1, Eq.*

9(31), through considering $\alpha_{e1}=\alpha^2$, α_1 corresponds to the deviation degree of reversibility, *Sec. 2(1)1, Eq. 2(7),* in a bi-dimensional (or circular) direction as in internal motion of H particle-paths of hydrogen atom at ground state. Alternately, α is electromagnetical form of a bi-dimensional deviation from reversibility. Noteworthy, considering a mass-body at rest, its internal H particle-paths move in all direction without any preference, *Sec. 2(1)1a, Fig. 2(1)*. Now, supposing a group of single direction of H particle-paths, e.g., photon exit from this mass-body, the initial equilibrium of H particle-paths of the mass-body is broken. Thus, the mass-body is moving by the lack of exited H particle-paths, i.e. $\alpha<0$, *Sec. 2(1)4, Note 2(1)4b*, and *Comment 9(4)6a*. In other words, the remainder H particle-paths constitute a internal bi-dimensional single direction H particle-paths as stated above. Note that, through exit of each unit of neutropa, *Sec. 4(4), Fig. 4(8),* of emitted photon of energy $a_1 h\upsilon = H N_p$, *Sec. 9(1), Eq. 9(9),* a group of α number of H particle-paths is formed by the rest of H particle-paths of related mass-body. In other words, N_p groups of H particle-paths are taken form at the end of hydrogen formation. Where, *H*, *Comment 1(1)1*, is the intrinsic energy, *Sec. 1*, of an H particle-paths, and a_1, *Comment 1(1)1,* is constant of media coefficient; *Note 1(2)1*, please refer to *Sec. 1(2)* in this regards. Therefore, N_p groups (or cells) of H particle-paths are taken form in each direction of electron shell of ground state at the end of hydrogen formation. As a result, $N_c=\alpha^2.N_{0e}$, *Eq. 9(60),* can be regarded as total number of common single-direction H particle-paths of electron-proton H system, i.e. group of H particle-paths of hydrogen atom per one unit of N_p units (or cells) created by ionization photon [i.e. α_1, *Sec. 9(3)1, Eq. 9(31)*], in a bi-dimensional direction such as electron shell in its ground state in hydrogen atom. In other words, $N_c=\alpha_1.N_{0e}=\alpha^2.N_{0e}$ is a number (or dimensionless constant at its maximum allowed level in a N_p cell in the ground state of hydrogen atom, *Note 9(4)6b*). Noteworthy, according to *Sec. 7(4)3, part E3*, at the ground state a bi-dimensional reverson, *Sec. 7(5),* closed sheet (or sphere surface) that is shielded by its bi-dimensional axeon prevents electron from further collapsing in the proton. Therefore, N_c can be regarded as total single-direction H particle-paths or neutropas of electron axeon (or *WR & WL* track texture of neutropa cells) on the reverson surface (reverax, *Sec. 7(5)3b*, *item II*,), *Sec. 9(4)7, item 13*. Thus, each composed of $N_c=\alpha_1.N_{0e}=\alpha^2.N_{0e}$ overlapped single direction H particle-paths (or neutropas). As a result, the reverson sheet is formed on the intersection of B vectors, *Fig. 4(4),* of negapa of electron and posipa of proton, *Sec. 9(3)1a*, at the end of hydrogen atom formation. It is surrounded by bi-dimensional axeon shield that is composed of $\frac{n}{2}=N_p$ cells; *Note 9(4)6a,* H particle-path groups; where n is the principal quantum number. In other means, through exit of ionization photon of energy $h\upsilon = H N_p$, *Sec. 9(4)7b*, the related reverson, *Sec. 7(5)3b*, is formed between proton & electron free space that is shielded by N_p cells of the related axeon shield (or reverax). Thus, prevent further collapse of electron-proton system as a ground state. Therefore, besides of individual intrinsic electron and reversons that are shielded by related axeons, the electron-proton system, i.e. Hydrogen atom, also has an axeon of N_c neutropas, *Note 9(4)6a,* in each of n principal state.

An isolated electron during its rectilinear motion has a linear path-limit Γ due to isotropic characteristic of free vacuum space, *Sec. 4(3)1, part B*, i.e. according to *Fig. 4(4),* each state of electron main-body through vacuum medium. It is associated with a group of surrounding N_c number H particle-paths that is along with expandon emission, *Simulation 7(4)2e1,* during electron transfer to a next state. However, in a curved space or curved single direction H particle-paths of both gravitational and electromagnetical fields of charged proton, the electron falling toward proton has both translational and rotational motion. Therefore, the path-limit Γ of the electron wrapped as a whirlpool down to ground state. This kind of whirlpool-like motion in each of its stages obeys the mirror Image effect, *Sec. 6(2)3*, that end by photon emission, *Sec. 4(3)*, as a result of the latter effect; please refer to *Sec. 4(3)3,* and *Sec. 9(4)7b.* From viewpoint of H particle-paths, the proton also undergoes such a whirlpool motion during electron falling based on Mirror Image Effect, which is confined to latter and initial space grace of its large mass ratio (*1900:1*) respect to electron accordingly. In other words, during both photon emission and absorption, the proton is associated in these phenomena analogous to electron. Resuming, the α^2 units has participated to closed rotational motion, and the N_p units of photon H particle-paths have contributed to bonding strength, *Note 9(4)6a*, of H particle-paths of electron, *Sec. 9(4)7, item* or proton (i.e. electron-proton H system as hydrogen atom) respectively as a result of Mirror Image Effect. Note that, to a circulating motion of H particle-paths or a group of that we can relate an angular momentum. Therefore, at the case of charged particles [or circulating H particle-paths as singlet, *Note 4(1)1*], we can attribute an magnetic moment, *Note 9(4)1a*. "It (fine-structure constant) was the quotient between the maximum angular momentum allowed by relativity for a closed orbit and minimum angular momentum allowed for it by quantum mechanics" [379], *History*; please refer to *Sec. 4(2).* Through *Sec. 9(3)1,* a detailed discussion is held on the scope of stated above units (or axeon's neutropa cells) during hydrogen formation. In fact, α^2 is equal to 5.32×10^{-5}, it must be multiplied by N_{0e}, i.e. the initial H particle-paths of the electron, *Sec. 2(1)3, Eq. 2(35),* at rest state in order to have a correct account of total H particle-paths, N_c neutropas of H particle-paths are shared to each state (or axeon's neutropa cell). Therefore, $N_c=N_{0e}.\alpha^2$. According to *Sec. 9(3)1, Eq. 9(31)* at the ground state and based on *Sec. 3(1)2, Eq. 3(20),* we have:

$$N_c=N_{0e}.\alpha^2=N_{0e}.\alpha_1=N_{\alpha e} \qquad \textit{Note 9(4)6b} \qquad 9(60)$$

Where, $N_{\alpha e}$, the returned or single direction circulating (closed) H particle-paths of electron in a hydrogen atom at rest. Thus, electron's $N_{\alpha e}$ is analogous to that of a free moving isolated electron, *Fig. 4(4), of Sec. 4(3)1, part B* as stated above, that is spread on a bi-dimensional closed surface of electron shell (or axeon) contrary to the *Fig. 4(4),* that is around a straight line.

By increment of fine structure α , *Sec. 9(4)6*, the deviation degree of reversibility, α_1 from reversibility also increases. In other words, through α increment, the total number of the neutropa cells will be increased, that leading to stronger coupling. Therefore, the electron frequencies, *Sec. 9(3)1, Eq. (17)* increase that corresponds to $N_{\alpha e}$ of electron in bounded state in hydrogen atom that is similar to the linear $N_{\alpha e}$ of a free moving electron, *Sec. 2(1)1b, Eq. 2(22)*. "A shorter distances corresponding to higher energy processes or probes (large momentum transfer), the screen is partially penetrated and the strength of the electromagnetic interaction increases since the effective charge increases" [388]. Please refer to *Sec. 5(16)3i*. "At an energy corresponding to the mass of *W*-boson (approximately *81 GeV*, equivalent to a distance of approximately $2\times10^{-18}m$), $\alpha_{(mw)}$ is approximately *1/128* compared with its zero-energy value of approximately *1/128* compared with its zero-energy value of approximately 1*/137*"[388].

Consequence 9(4)6a- At each instant merely one of the two conjugates is existing at once at expanded form, *Sec. 8(7)2, part E2*; while, the other one is nil, i.e. in contracted form. Therefore, at ground state, and absolute zero, merely half of the energy can be revealed simultaneously related to half of the wavelength during stay time interval ΔT , *Sec. 7(4)2f, part A*, , i.e. $1/2h\upsilon$, Please refer also to *Sec. 5(16)3c,* and *Sec. 8(2)3*.

Note 9(4)6a- "In the ground state of a hydrogen atom, the electron has a characteristic probability density which describes the probability of locating the electron within a given radial region from the nucleus. If the *FWHH* of the probability density is approximately 0.05 nm, what is the minimum uncertainty in the radial component of the electron's momentum?, i.e. $\Delta p_r = 2.1\times10^{-24} k_g.m/s$ "[371] *Problem supplement No. 2*. However, according to *HPPH*, *Sec. 8(7)2, Part G*, during any stay time interval ΔT_e (at the anti node, *Simulation 3(1)2a*) merely a state of all of the states of a particle is in the expanded form; while, the remaining of its states are in the contracted form, *Sec. 9(4)7, item 7, i.e.* nil. Any expanded state of electron in the electron-proton common shell at ground state during the stay time interval ΔT_e emits a gravitational *G*-expandon (accompanied by overlapped electromagnetical negaton, *Sec. 4(6)4*) that is along with releasing *G*-contracton (accompanied by overlapped negactron) during infinitesimal stay time interval ΔT_c (at the node) towards the related expanded state of the proton. This phenomenon is via the one of the N_p cells on electron-proton common shell that is along with *G*-contracton (overlapped with posictron) realizing, *Sec. 5(9)3d*, by proton towards the expanded state of electron and similarly, due to an expandon (overlapped with positron) emission by the proton. Thus, during this phenomenon, both electron and proton individually emits *G*-expandon and *G*-contracton and related electromagnetical conjugates, *Sec. 4(6)4*. The above discussion implies that hydrogen atom at ground state (at absolute zero temperature) has non-zero intrinsic vibrational energy $\frac{1}{2}h\upsilon$, *Remark 5(16)3c1,* and *Sec. 5(16)3c, d*; please refer also to *Sec. 9(4)7b, Comment 5(16)5a* for a similar assumption. Factually, according to above statements, the electron in hydrogen atom at ground state has two non-zero N_p cells of half the wavelength energy magnitude that are reversed handed of each other, i.e. *WR & WL* configuration of expandon emission successively during stay time interval ΔT . In other words, if *WR* is in expanded form, its reversed handed conjugate, the *WL* is in contracted form, i.e. nil, *Consequence 9(4)6a*, or vice versa successively, *Sec. 8(7)2, E2*. As the result, the expanded state emits a *WR* (or *WL*) expandon overlapped on negaton (or positons) of path-length value $2\hbar$ during stay time interval ΔT at the antinodes. While, it is accompanied by releasing *PL* (or *PR*) overlapped gravitational and electromagnetical contracton at the node that are transferred to the supermassif black hole of the host galaxies or clusters via H hall package tunnel of path-length value $-2\hbar$, *Sec. 5(9)3d, part c.* The exchange of electromagnetical contractons (negactron and posictron, *Sec. 4(6)4*) between electron and proton fortifying the bonding strength in hydrogen atom respect to simply weak gravitational attraction related to *G*-contractons, the van der Waals forces, *Sec. 9(2),* between the molecules can be related to mutual interaction of their residual electromagnetical expandons (negatons and positons) *Sec. 4(3)1, part c*.

Note 9(4)6b- Factually, $N_c = N_{0e}.\alpha^2 = N_{0e}.\alpha_1 = N_{\alpha e}$ can be interpreted as electromagnetical equivalent of n_s , *Sec. 5(1)1*, the total number of Planck area in gravity related to N_p number of H particle-paths. Thus, α^2 can be electromagnetically equivalent to Planck area accordingly. Referring to *Sec. 5(2)1b*, in case of equivalent stage, e.g. hydrogen atom, N_c also is equivalent to n_g , i.e. symbolic number of H particle-paths (here single direction H particle-paths) due to summation of entered *CF*-force lines by mass *M* (here proton) done in H system m , e.g. here electron, in a stable equilibrium motion, *Eq. 5(10), item II*. Noteworthy, in above equation, N_c is related to ground state of deviation degree of reversibility α_1 . Therefore according to *Eq. 9(31)1*, in case of principal state n we have:

$$N_{cn} = N_{0e}.\alpha^2.\frac{1}{n^2} = N_{0e}.\alpha_n = N_{0en} \qquad 9(60)a$$

Where:

- N_{cn} , the total number of single direction H particle-paths in a N_{pn} cell in principal quantum state n , related to deviation degree of reversibility α_n . Thus, N_{0en} is the returned single direction H particle-paths of electron in principal state n .

Comment 9(4)6a- In order to not to be confused α , *Sec. 2(1)1a, Eq. 2(7),* with α of fine structure constant, the former is shown by symbol α_1 in *Sec. 9*.

9(4)7- Explanation of Fig. 9(3)a

9(4)7a- General aspect

1) The path-limit Γ of electron in each of its principal state n is equal to $\Gamma = 2\pi\, a_0 = 2\pi\, \lambda_e$, *Sec. 9(3)1a*, in the n^{th} principal state.

2) The minimum periphery P (or path) of electron track texture in the n^{th} principal state is an integer of its path-limit Γ, i.e. $P = n\Gamma$, where n is the principal orbital number; *Note 9(4)7a.*

3) The spherical state S is constituted of N_p cells of track texture; *Note 9(4)6 b.*

4) Electron is merely in one of its N_p cell (or *WR or WL* track texture cell), during a stay time interval ΔT , *Remark 9(1)2, part A*.

5) During the motion of electron main-body in clockwise respect to reader page, the magnetic vector *B* is normal and upward to the reader page during each stay time interval ΔT , *item 4* (or vice versa).

6) According to *Simulation 7(4)2e1*, and *Sec. 5(16)3b,* the electron constitutes an electromagnetical track texture sphere equivalent to gravitational sphere, *Sec. 4(6)4*, and *Sec. 5(4)*, constituting of N_p area (or cells), *Sec. 9(6)4b,* each constituting of N_c single direction H particle-paths.

7) According to *Sec. 8(7)2, part E2*, the expanded mode of electron in each of its area or cell is terminated at the end of stay time interval ΔT , *Sec. 7(4)2f, part A*, with negactron, *Sec. 4(6)4*, emission towards the proton in hydrogen atom that is along with posictron release towards the electron main-body via related H hall package tunnel; please refer also to *Sec. 5(9)3d, part c*. Noteworthy, based on *Sec. 8(7)2, part G*, an expandon is emitted from an expanded N_p cell that is along with *G*- contracton overlapped on electromagnetical contracton (or negactron) releasing towards the proton or vice versa. The N_p cell that becomes expanding during infinitesimal stay time interval ΔT is managed and selected by related supermassif black hole of host galaxies, *Sec. 5(15)3d, part B, proposal 3*. Noteworthy, according to *Sec. 7(5)3d, part B, item II*, the electromagnetical contracton (*E*-contracton , *Sec. 4(6)4*) are accumulating in the *G*-reverson of electron during electron transfer in the levels, e.g. levels n , up to reach a critical value, *Note 7(5)3d, B4*, related to decay process, i.e. photon releasing at the end of critical time interval, ΔT_{CRIT} , *Eq. 7(47),* from combined electron-photon system, i.e. excited electron, *Sec. 7(4)2b, Eq. 7(20)*. Thus:

$$\Delta T_{crit} = n\,\Delta T_e \qquad 9(60)b$$

Where:

- ΔT_e , is stay time interval of electron in an expanded state of one of its track texture cell (or N_p cell) in a level of n levels

- n The number of a level that has values from $n = 1$ to $n = \infty$.

At the end of ΔT_{CRIT} , a photon is released from combined electron-photon system.

8) According to *Sec. 2(3)1a*, the electron-proton system in hydrogen atom in ground state is a stable state, i.e. there is no further attraction of electron towards the proton.

9) According to *Sec. 7(4)2d*, electron in each of its area or cell on its track texture (or orbit) surface is reversed handed of its adjacent cells. In other worlds, electron during its transfer to an adjacent cell changes its handedness configuration, *Simulation 7(4)2e1*, i.e. type *R & L* cells.

10) Electron main-body during its tangential motion in a direction of a tangential periphery, e.g. $n = 9$ (or N_p=18) (as in *Fig. 9(3)a*), can be transferred radially to another periphery, e.g. $n = 8$, or moving at opposite direction as well, i.e. $n = 10$.

11) Any two adjacent track texture spheres (levels, or peripheries), e.g. related to $n = 9$ (as in *Fig. 9(3)a,* and $n = 8$ are separated by a reverax, *Sec. 7(5)3b*, *item II*, sphere, *Comment 9(4)7a,* due to emission of photon from level $n = 9$ to a lower one, e.g., $n = 8$ down to $n = 1$ related to ground sphere of excited electron, *Sec. 9(4)7c*, or vice versa in case of photon absorption. Please refer also to *Sec. 7(4)2b*.

12) To any electromagnetical track texture sphere imparts energy equal to CRh. In other words, a sphere of e.g. N_p track texture cells per periphery related to level $n = 2$ (i.e. $N_p = 4\pi n^2 = 16\pi \approx 50$ total track texture cells on its sphere surface), to each of its track texture imparts $\dfrac{CRh}{4\pi n^2}$ energy. Therefore, an electron that is absorbing by a proton to form hydrogen atom at each level lose $\dfrac{CRh}{4\pi n^2}$ energy down to ground state. In other words, electron during a cascade of energy level from $n = \infty$ to $n = 1$ lose energies of magnitude $\dfrac{CRh}{4\pi n^2}$ during falling at each level down to ground state in the form of a photon, Thus, a photon can be represented as neutropas, (or cells) *Sec. 9(4)7c,* compactified on each other. Moreover, the circulating speed of electron

(constituting of reversible H particle-paths at rest state) during losing single direction neutropa, *item 17*, at each level is increased stepwise according to:

$$v_{cm} = \frac{32\varepsilon_0^2 h^3 c^3 R^3}{Z^3 m_e e^4} \cdot \frac{1}{n^3}$$

Please refer to reference [4] *chapter 51, Eq. 14,* and *item 17*.

Based on *HPPH*, a single direction negapa of electron of SN_r configuration is combining by a single direction posipa of proton of SP_l configuration during electron passage in each level to form neutropa of photon. The radial falling of electron is along with irreversible path-length, and time arrow, *Sec. 5(16)7*; while, the electron tangential motion is accompanied by reversible path-length related to *T*-symmetry, *Sec. 9(4)7c, item 4*. Therefore in the former, electron is along with photon emission, or vice versa related to time's arrow or its reversal; while, in the tangential case, the electron accelerating motion has no radiation due to *T*-symmetry, *Sec. 2(3)3*. Please refer to *Sec. 5(16)1b, part F* , and *Sec. 8(7)2, part G, item F*, in this regards.

13) The single direction negapa of the electron field as singlet, *Note 4(1)1*. During its turning about the electron in an excited state in hydrogen atom, e.g. level number *9*, turn also around the proton on the second circle b as in *Fig. 9(3)a*, of wavelength λ_9; please refer also to *Fig. 4(4)* in this regards.

14) By analogy to *Fig. 5(8)* of gravitational field, the track texture of electromagnetical field constituting of N_p cells as in *Fig. 9(3)a*, construct a counter-current motion, *Sec. 3(1)2*, of H particle-paths in all of the tangential directions. Thus, the electron main-body can be finding at any stay time interval ΔT in a type *R* or *L* expanded cell on track textures. At the end of time interval ΔT , it transfers to another expanded track texture cell in tangential directions. The transfer of electron main-body to an upper level depends on photon absorption in baby H hall package as in *Sec. 7(4)2b*, *Eq. 7(20),* or, vice versa during photon emission by excited electron.

15)- The path-length related to a complete beat, *Sec. 5 (9)3d, part D*, can be regarded as minimum possible path-length of the particle, *Remark 7(4)3, E2a,* of total magnitude h . In other words, the main path-length is constructed of two opposite handedness (or opposite sign) of type *R & L* path-lengths each of equal magnitude $h/2$, *Simulation 7(4)3, E2a*. The minimum path-length imparts a limit on ground state in the related medium, i.e. H hall package, *Sec. 5(16)3*, of path-length value $h/2$. Any two adjacent opposite handed cells on track texture as in *Fig. 9(3)a* represents the H hall packages in its different type *R & L* configurations due to intersection of two spatial and mass medium, *Sec. 7(4)3*. Thus, the principal quantum number n in a level can be considered as the total number of H hall packages in the level. In addition, during any $\Delta T_{p(E)}$ stay time interval, *Sec. 7(4)2f, part A*, *Sec. 8(7)2, part G*, an H hall package in this respect has its true existence at its expanded form during that stay time interval. Based on *items 4, 14*, the electron main-body acquires type *R* (or *L*) configuration successively on ground state *Sec. 8(2)3*, ($n = 1$) along with type *WR* (or *WL*) expandon emission at the antinodes, *Simulation 3(1)2a*, during stay time interval $\Delta T_{p(E)}$ and *PL* (or *PR*) contracton releasing at the node, *Simulation 7(4)2e1*, at infinitesimal stay time interval $\Delta T_{p(C)}$. In other words, electron at its expanded mode during stay time intervals $\Delta T_{p(E)}$, $\Delta T_{p(C)}$ of a beat emits related expandons and contracton as stated above respectively; while, its other states are contracted, i.e. nil. Please refer also to *Sec. 5(16)1b, part G.* Factually, the electron's track texture cells of successive types *R & L* configurations in a level can be compared with expandons cell in *Sec. 5(16)1b, part A, item 26 of Fig. 5(8)* explanation. Therefore, during electron stay time in a cell, the latter is expanded & subsequently contracted based on *Sec. 7(4)2f, parts E*; while, the other track texture cells of the level are nil.

16) According to *Sec. 8(7)2, part G, item G*, any excess of number of track texture cells in a level respect to its lower one is related to the increment of time's arrow in its radial transfer along with related spatial expansion (or vice versa).

17) based on *Sec. 9(4)7c*, during photon absorption by electron in an hydrogen atom in a step-like manner, the *WR* or *WL* neutropa, *Simulation 7(4)2e1*, in H hall package of photon are transferred successively to H hall package of electron up to reach to a baby H hall package in case of photon, *Sec. 7(4)2b*. In other words, the type *R & L* neutropas each of $\frac{cRh}{n}$ energy, *item 12*, are transferred (or picked up) from H hall package of photon to that of excited electron successively, *Remark 9(4)7a,* during stay time interval ΔT , *Sec. 8(7)2, part E2*. Therefore, in case of photon emission by excited electron, the reversed process is taken place, *Sec. 9(4)7b*. Factually, during any beat in photon-hydrogen atom H system, two groups of types *R & L* cells are engaged, *Comment 9(4)7b*. Thus, depending on the direction of the *WR* or *WL* neutropas, the electron moves (or transfer) in the related direction during infinitesimal stay time intervals $\Delta T_{p(E)}$. e.g. from a track texture cell of type *R,* to its adjacent type *L* along with *PL* or *PR* contractons emission towards the proton in a hydrogen atom, i.e. a sequential motion of electron in an orbit. Moreover, the angular momentum of electron successively changes in types *R* or *L* configuration. As a result, the hydrogen atom medium, *Sec. 7(4)3, part E3A*, has H hall package each of cRh energy. In other words, in this medium energy changes by cRh factors.

18) According to *Sec. 8(7)2, part E2*, and discussion held on *item 17*, the electron can be found merely in one of its track texture cell in a level at an expanded state, *Sec. 8(7)2, part G*, during infinitesimal stay time interval $\Delta T_{p(E)}$. While, the all other states of electron in the level in other of its track texture cells of levels are in contracted mode, i.e. nil. Therefore, at each instant the electron can be found merely in one of its expanded states. It leading to probability of finding an electron in one of its states. Thus, the denser track texture in a level (or location) leading to more probability of electron finding in that location; please refer also to *Sec. 7(4)2e,* and *Sec. 8(1)1*. Moreover, according to *Note 9(4)6a,* at the ground state (level $n = 1$), the electron in its type *R & L* states have single direction motion of energy $\frac{1}{2}h\upsilon$. As a result, according to above discussion, the electron along with its expandons on its track texture (electron matter wave counterpart, *Sec. 5(6)*) at each level reveals as an electron cloud in that level.

19) During hydrogen atom formation of an electron and proton, the former in the levels (or orbits) moving with the lack of single direction H particle-paths. It is equal to H particle-paths of emitted photon respect to electron at rest state before interaction, due to its negative energy (related to bonding or ionization energy), *Proposal 3(1)1a*.
20) An isolated atom, e.g. a hydrogen atom, is confined in an H hall package. In case of a mass-body constituted of multiple atoms the number of H hall packages is equal or less than the number of mass-body atoms, *Consequence 2(10)1b*.

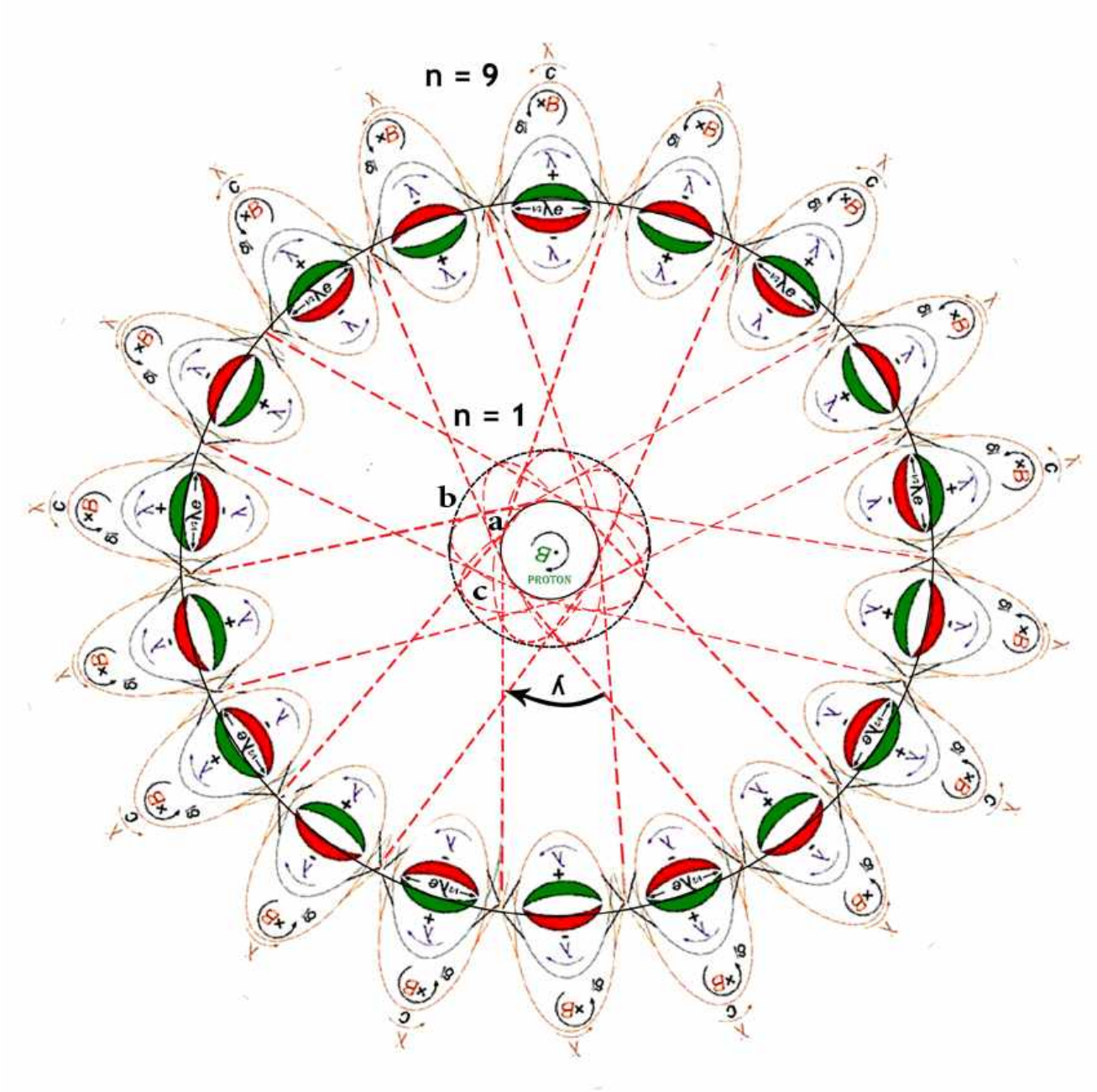

Fig. 9(3)a- Schema of electron track texture path in an orbit, e.g. of hydrogen atom of $n = 9$, (or N_p=18), *Note 9(4)7a*

The electron motion in an orbit*, Fig. 9(3)a*, is analogous to case of the motion of reversible H particle-path or a group of that in a medium; please refer to *Remark 1(1)4,* and also to *Note6(2)6c2*.

Note 9(4)7a- "If we represent the circulating electron in terms of its de Broglie wave, then the stationary state are those in which the electron's de Broglie wave joins onto itself with the same phase after each revolution. Otherwise, the wave would destroy itself by destructive interference, put another way, the de Broglie wavelength must fit around the circumference of the orbit, *Fig. 9(4)7a,* an integral number of times, or

$$n\lambda = 2\pi r \qquad n = 1,2,3,..... \qquad 9(61)$$

As suggested by *Fig. 9(4)7a*, substituting $\frac{h}{p}$ the de Broglie wavelength in this expression leads directly to *Eq. 9(62)*:

$$L_n = n\left(\frac{h}{2\pi}\right) = n\hbar \quad n = 1,2,3,..... \qquad 9(62)$$

"[4] *4th ed. Chapter 51-1, page 1074.*

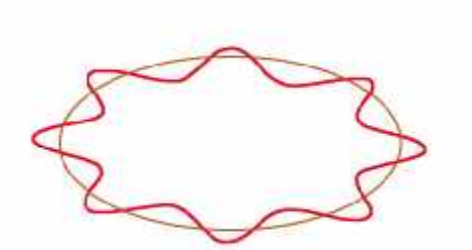

Fig. 9(4)7a- The deBroglie wavelength fit around the circumference of the orbit

According to above discussion, the track texture of electron around the nuclei construct H hall package units each of path-length limit $\Gamma = \lambda$ in a total path $P = n\Gamma = n\lambda$ due to counter-currency mode of motion, *Sec. 3(1)2,* of negapa-posipa of matter wave, *Fig. 3(5)*, of SN configuration.

Comment 9(4)7a- In *Fig. 9(3)a*, The central sphere a is the reverson zone; while, the spatial medium c between spheres a, and the middle sphere b is the axeon shell that shields the reverson. Thus, constituting the reverax, *Sec. 7(5)3b, item II*, as a spherical sheet.

Comment 9(4)7b- Factually, principal quantum number of a level $n = 2N_{pn}$, *Sec. 9(4)7, item 12*, i.e. the neutropas of photon remained engaged in the beat related to level n, or cycle of electron beat in this level. Therefore, the electron beat is the same as photon beat in a level during photon absorption by an atom. As a result, the absorbed photon with related electron constituted a unique H system, *Sec. 8(5),* with a same beat or cycle; please refer to *Sec. 7(4)2b.* Thus, forming a moving electron at v speed constituting of n_{0e} H particle-paths at reversible motion (electron part), and $n_{\alpha e}$ single direction H particle-paths (neutropas of photon part).Please refer also to *Sec. 4(3)1, part B*.

Remark 9(4)7a- The photon H particle-paths of single direction characteristics are absorbed by electron up to full absorption along with step-wise transfer of electron-photon (excited electron H hall package, *Sec. 7(4)2b, Eq. 7(20)*) to related level during stay time interval ΔT, *Sec. 7(4)2f, part A*, in such a manner that ultimately the relation $\Delta E.\Delta T = h$ is hold; where, ΔE is the photon energy of N_p H particle–paths. Factually, the electron obeys the classical motion of electron in hydrogen atom during ΔT time interval based on Bohr model. At the end of time interval ΔT, the reverse processed is performed up to reach the electron to a lower level at step-wise manner, *Secs. 7(4)b, c,* and ultimately to ground state along with photon emission. In other words, the *WR & WL* cells (or main expandons) of main photon body are engaged in this case. As a result, at the full electron-photon stage, an H hall package of excited electron is constructed, *Eq. 7(20)*. Factually, during each step of *WR or WL* cell of photon absorption by electron, the H hall package of excited electron expands to next upper level and conversely during photon emission, the electron-photon excited system contracts accompanied by of *WR & WL* cells of photon transfer to baby H hall package, *Eq. 7(20)*, of photon down to ground state, *Sec. 8(2)3*.

9(4)7b- Photon formation & absorption by an orbit, e.g. of hydrogen atom

During electron falling towards the proton in any radial transition, the following process are accomplished as follow:

1- The baby H hall package, *Sec. 7(4)2b, Eq. 7(20),* of excited electron acquires in each level, e.g. n, $N_{p(n)}$ groups of N_c H particle-paths of *WR &WL* electromagnetical expandons, *Sec. 4(6)4,* (i.e. negatons) in that level successively. They can be regarded as electron track texture, *Sec. 5(16)3b, part B*, in spatial medium, *Sec. 7(4)3, part A,* in that level.

2- During $N_{p(n)}$ groups formation (case 1), each group emits N_c *PR & PL* electromagnetical contractons, *Sec. 4(6)4*, (i.e. negactron) towards the proton via $N_{p(n)}$ H hall package, *Sec. 5(9)3d, part C*. They are along with mutual $N_{p(n)}$ posictron emission by proton towards excited electron.

3- In orbit $n-1$, similarly to scenario as in *cases 1 & 2* takes place. Moreover, $N_{p(n)} - N_{p(n-1)}$ *WR &WL* electromagnetical expandons combined with $N_{p(n)} - N_{p(n-1)}$ posictron emitted from the proton (*case 2*) in order to form $N_{p(n)} - N_{p(n-1)}$ overlapped successive types *R & L* single direction H particle-paths in baby H hall package unit, *Consequence 6(2)3a*, to form a photon. Noteworthy the orbital n along with its H particle-paths are eliminated and appeared merely as orbit $n-1$; please refer to *Sec. 8(7)2, part E2,* when electron stay in orbit $n-1$.

4- Similar scenario as in *case 3* is occurred in orbit $n-m$ of electron in order to form $N_{p(n-m)} = N_{p(n)} - N_{p(m)}$ single direction H particle-paths of photon formation, *Note 6(2)6b1,* in the baby H hall package unit. According to *Sec. 8(7)2, part G*, electron is in its expanded modes (or states) during stay time intervals ΔT, *Sec. 7(4)2f part A*; while other electron states are in contracted mode.

5- In case of photon absorption by electron in hydrogen atom, the reversed processes as stated above are performed; please refer to *Sec. 9(4)7a*.

9(4)7c- A proposal of photon structure

According to *Secs. 9(4)7a,b,* and based on *Sec. 5(16)1a, part A, Eq. 5(49),* a photon can be regarded as a contracted superimposed single direction *WR & WL* expandons, *Sec. 6(2)6b, part B*, or its $\overline{WR}$ or $\overline{WL}$ conjugates, *Simulation 7(4)2e1*, (or contracted neutropa, *Sec. 1(5).* It can be evolved according to *Simulation 7(4)2e1* during its travel in free vacuum medium, i.e. a reversed process respect to the former one (or photon formation, *Sec. 9(4)7b*). As an example, considering a book that is made of pages of even (*WR or* $\overline{WR}$) and odd (*WL* or $\overline{WL}$) numbers, e.g. photon formation. In normal vacuum medium gradually *WR & WL* pages or related $\overline{WR}$ or $\overline{WL}$ conjugates are detached from the book, *Simulation 7(4)2e1*. or better to say a bunch of stored *WR* or $\overline{WR}$, and *WL* or $\overline{WL}$ H particle-paths of compacted expandons, *Sec. 4(4), Fig. 4(8),* about the photon single direction motion by far analogy to cellular structure of trunk of a tree. Thus, according to *Eq. 3(27)a*, there is a radial motion of H particle-paths of internal wavelength Λ_0 , *Remark 3(1)1c,* and *Sec. 7(4)4, case II,* in radial direction perpendicular to the single direction motion of photon main-body. Thus, there is a radial motion from the central axis to the periphery along with *WR*, $\overline{WR}$ & *WL*, $\overline{WL}$ expandons emission and a backward motion from periphery towards the central axis during a beat, *Sec. 5(16)2a, part A*, and *Sec. 7(5)3d, part D*, along with *PR*, $\overline{PR}$ & *PL*, $\overline{PL}$ contracton releasing from the central axis of photon-main-body towards the source of photon. Please refer also to *Sec. 5(7)6* for further information.

Noteworthy:

1) The single direction H particle-paths of a photon despite of its types *R&L* in related expandons have merely a unique reverson, *Sec. 7(5)* (or combined reverson, *Sec. 7(5)b, part B*). Thus, the photon as a particle is confined merely in an H hall package of path-length value h with a unique reverson that during any stay time interval, *Sec. 7(4)2f, part A*, emits a type *R* (or *L*) expandon around photon axeon (or reverson) of path-length value $+2\hbar$ that is confined in an H hall package. The expandon emission by photon is accompanied by type *L* (or *R*) contracton releasing of path-length value $-2\hbar$ via H hall package tunnel to the related supermassif black hole of the host galaxies, *Simulation 8(7)2, E5a*.

2) The contractons are released in the direction of photon propagation, but at its opposite direction.

3) The contracton absorption by related supermassif black hole is along with time's arrow, Sec. *5(16)3f, part B,* and whole photon main-body transfer to the next H hall package in spatial medium, *Sec. 7(4)3, part A*. This phenomenon is accompanied by increment of H hall packages number by newly born expandon in spatial medium, i.e. spatial expansion Sec. *5(16)3b, F1*.

4) According to *Sec. 2(4)4b*, the irreversibility of path-length leading to time's arrow, spatial expansion due to newly born H hall package of expandon, *item 3*. Therefore, the photon red-shifted due to self-accelerating expansion, S*ec. 5(7)8*. The *Fig. 9(3)a*, is an example of irreversible expansion, In other words, the electron upper level has a newly born track texture cell (or H hall package during a stay time interval ΔT respect to lower one. This example is a *T*-symmetry example of reversible path-length, *Sec. 9(4)7, item 12*, contrary to the former irreversible case of photon red-shifting.

9(5) - Electromagnetic rest mass

The gyromagnetic ratio, *Sec. 9(4), Eq. 9(46),* is an estimation of the effect of an right or left-handed H particle-paths interaction as singlet respect to that moving at counter-currency mode of motion, *Sec. 3(1)2.* In other words, it can be regarded as H particle-paths singlet affinity respect to that of the mass of electron, m_e i.e. the non-singlet one. The presence of former as singlet revealed by its electromagnetic interaction and the latter by its inertial mass mechanical interaction at counter-current reversible mode. Factually, energy variation of these two different cases is the same, i.e. integer number of h, independent of the kind of interaction. As a result, the gyromagnetic ratio can be considered as affinity (or probability} to the related interaction of singlet H particle-paths respect to the counter-current ones; moreover, e and m are the representatives of interaction of H particle-paths in their related singlet and counter-current forms; please refer for additional information to *Sec. 4*.

Generally speaking, electromagnetism and mechanic deal on interaction of singlet and counter-current H particle-paths respectively, or in other words, e can be regarded as electromagnetical rest mass, whereas m as inertial or gravitational mass according to their related interaction. Factually, rest mass is a measure of reversible motion of H particle-paths equally in all of direction, i.e. H particle-paths at counter-currency mode of motion, which lead to inertial and gravitational masses accordingly. Similarly, H particle-paths as singlet (negapa or posipa) lead to electromagnetical mass. These discussions respond to the question why electrostatic law is similar to gravitation law, *Sec. 5(1).*

By a sophisticated proposition, electric charge magnitude of a fundamental particle in an H hall quantized package can be related on the rate of expansion of its expanding potential surface, *Sec. 4(6),* on the basis of right- or left-handedness geometrical feature of the space expansion. In fact, expanding potential surface of a fundamental particle field has a dual characteristic according to its related interaction as following:

I) Electrical (reveals as effect of electromagnetical mass e)

II) Gravitational (reveals as effect of mechanical mass m)

Please refer also to *Sec. 4(6)2, Eq. 4(27).*

10- Particles

10(1) -Combined H systems

Considering Hydrogen atom as a binary electron-proton H system, and comparing it with the moving free electron, model, *Sec. 4(3)1, Part B, Fig. 4(4) ,* we can assume any free moving elementary particle as a binary particle-photon or better to say particle-neutropa H system at fermionic style , *Note 10(1)1*. In other words, an intermediate state of particle at rest with mass (purely reversible forward-backward motion of H particle-paths) and neutropa with zero rest mass (e.g. single direction H particle-paths). Moreover the total spin magnitude of a free binary H system as stated above is $\hbar$ (refer to *Sec. 3(1)1, paragraph IV*), *Eq. (17)1.*

As a result, the structure of an electron is extended along the photon direction, as a tool of investigation of electron structure. Moreover, the same similarity occurred as in hydrogen atom around the proton axeon, *Sec. 10(8).*

Note 10(1)1-Photon is entangled with its pair (or source), *Sec. 8(7),* as counter-current H particle-paths before measurement*, Sec. 8(7)2,* of one photon, the other is regarded at co-direction posipas and negapas, *Fig. 4(8);* please refer to *Comment 8(1)3b.* Neutropas with fermionic structure, can be considered as a moving electron axeon, *Sec. 10(8),* in which posipa and negapa moving according to counter-currency mode with SP or SN configuration (color charge), *Sec. 3(1)2*, *Fig. 3(5).*

10(2)-Quarks and leptons

The quarks as hadrons constituents, are collection or set of posipa and negapa H particle- paths that the sum of their charges in the collection, or, in other words, their selective spatial spin interactions, *Sec. 4(5),* are a fraction of the magnitude of the integer electron or positron charge. Similarly, leptons are also a collection of posipa and negapa with the total charge, *Sec. 4(5),* equal to electron or positron charge magnitude. If one of the quarks in a given hadrons is pulled away from its neighboring quarks (i.e.

entrance H particle-paths as posipa and negapa configurations) the color force stretches between that quark and its neighbors and increases as they pulled apart. In other words, the color charges resist to splitting and the adequate posipas and negapas compensate in the favor of charge formation, i.e. the entered H particle-paths in the form of neutropa providing the adequate posipa and negapa, *Sec. 1(5), Eq. 1(2)*. According to [35]" To give birth to the new charged particles regarding the internal color charges of its constituting quarks". As an example:

$$\begin{matrix} -2/3e \\ +2/3e \end{matrix} \begin{matrix} \rightarrow c \\ \rightarrow c \end{matrix} + \text{neutropa splitting (force)} \rightarrow \begin{cases} \bar{c} + negapas(equivalent\ \ to -1/3e) \rightarrow \bar{c}\,d \\ c + posipas(equivalent\ \ to +1/3e \rightarrow \bar{d}\,c \end{cases} \qquad 10(1)$$

As the result, the H particle-paths (i.e. posipa and negapa) behavior as above and its exchange characteristic between the cells of hadrons analogous to *Sec. 9(3), Fig. 9(2)*; *Fig. 10(1),* bind the hadrons in a nucleus.

10(3) - Charged pions

Considering π^- meson moving at v speed with its two of its constituent's quarks $\bar{u}\,d$; moreover, analyzing its charge by analogy with that of a moving electron *Sec. 4, Fig. 4(4),* we have:

$$\begin{matrix} -\delta e = -2/3e \\ \lfloor \bar{u},\ e = -2/3e \rfloor \end{matrix} \quad <> \quad charge = -e \quad <> \quad \begin{matrix} +\delta e = +2/3e \\ \lfloor d, e = -1/3e \rfloor \end{matrix} \qquad 10(3)$$

According to *Sec. 10(7), Note 10(7)1*, related to a moving particle, *Eq. 10(12*), we can considering the π^- as a moving particle with N_0 initial H particle-paths in forward-backward motion plus N_α single direction H particle-path with partial charge *-2/3*e at back and *+2/3*e at its front of motion thus:

$$N_\alpha = 2/3\, N_0 \qquad 10(4)$$

According to *Eqs. 2(7), 2(35), 2(77)* and assuming mo as the rest mass of π^-, we have:

$$\alpha = 2/3 \qquad 10(5)$$

$$V = 0.55C \cong 1/2C \qquad 10(6)$$

We can compare a π^- with integer charge and initial H particle-paths number, N_0, moving at least *V= 0.55* speed of light. According to the, *Sec. 4(3)2, case3* by changing $e^- \rightarrow e^+$, the similar result will be obtained respect to π^+ with $u\,\bar{d}$ quarks configuration

$$\begin{matrix} +\delta e = +2/3e \\ \lfloor u\ ,\ e = +2/3e \rfloor \end{matrix} \quad <> \quad charge = +e \quad <> \quad \begin{matrix} -\delta e = -2/3e \\ \lfloor \bar{d}\ ,e = +1/3e \rfloor \end{matrix} \qquad 10(7)$$

According to the above comparison, and considering, *Eqs. 10(5), 10(6)* the *V*= 0.55*C* is the least speed that a π^- and π^+ may be had. In the other words, a charged pion in its combined state with other particles (e.g. nucleus) has a common internal motion of its H particle-paths, *Sec. 1(3)*, at *V= 0.55C* speed, *Eq. 10(6);* moreover, the main differences (regardless of the mass) are:

I) At the electron case, $-\delta e$ and $+\delta e$ have the same spin direction as electron. For this reason, the electron H system is stable during motion

II) At the case of the pions $-\delta e$ and $+\delta e$ fractions, or, in the other words, the quarks have different spin directions that leading to pion decay.

10(4) - Quark's arrangement

10(4)1- Proton's quarks arrangement

I) Supposing 3 imaginary cylinders of equal base radius located at *3* locations $l,\ m\ ,r$ in such a manner that one third of l and r cylinders volumes are overlapped totally by two third of volume of cylinder m,. Moreover supposing three integer charges located at $l\ ,m\ ,r$ with equal magnitude of electron charge, i.e. two positive sign at $l\ ,r$ and one negative at m ;thus the total charge of the proton H system is equal to $+e$.

II) Considering cylinders $l,\ r$, have the identical spin at SN_l and SN_r configurations respectively, and cylinder m at opposite spin and SP_m configuration, *Fig. 10 (1).* The arrows indicate the posipa and negapa direction of motion in this figure.

III) groups of H particle-paths exchanges between the quarks of imaginary cylinder surfaces, $l,\ r,\ m$, *Fig. 10(1)a,* in accordance with the right-handedness , i.e. negapa-negapa as in , *Fig. 9(2),* or, left-handedness , i.e. Posipa-Posipa, *Comment 10(4)1a*. Moreover, the manner of exchange is illustrated in viewpoint of quark spin, *S*, directions. Please refer to *Example 10(4)1a,* and *Note 7(4)3, E2d.*

IV) In the moving electron model, *Fig. 4(4),* we encounter with a single SP configuration, *Sec. 3(1)2*, *Fig. 3(5),* of neutropa at the *x* -axis motion direction. At the proton case, we have a set of three quarks, *Note 10(4)1a,* configuration respect to posipa and negapa motion directions, (SN_l , SN_r , SP_m), *Comment 10(4)1b*. Please refer to *Sec. 3(1)2, Comment 3(1)2b*. It provides the required posipas and negapas for photon emission and absorption during an interaction process similar to *Fig. 4(5)* with other charged particles i.e. proton during hydrogen formation or ionization process with electron. Moreover, the repellent force, because of interaction with external H particle-paths field-line [i.e. similarly to *Fig. 4(4)* of moving electron] of other neighboring protons in the nucleus is ended by the *B* vector coupling *Sec. 9(3)1*. Additionally the exchange characteristics of negapa and posipa between quarks of neighboring protons in nucleus, as residual color force hold the protons. Therefore, this stabilizes the nucleus.

V) Considering two neighboring protons (or neutrons, or proton-neutron), there is a probability that SN_l quark of proton coupled with SN_r of other neighboring proton at opposite spins through related mesons interchanging, thus, transferring the old SP_m configuration by a new SP_m one, a newly formed quark triplets in each of these two protons.

"The new updated quark-meson coupling (*QMC*) model of the nucleus takes into account both the fundamental interaction among quarks within the neutrons and protons making up a typical nucleus and the interaction among the neutron and protons as depicted as meson interchanges between pair of quark"[316]. Therefore, the quarks transfers through coupling configuration, similar to the case of correlated pair of electron, *Sec. 9(2), Note 9(2)4, Remark 10(4)1a.*

Analogous to *Sec. 9(2), Fig. 9(2),* the posipa or negapa configurations of any two adjacent units (e.g. *A1, A2,* or *A2, A3*, or *B1, B2;* …etc. units), *Fig. 10(1),* can exchange between u and d quarks in accordance with mirror image effect, *Sec. 6(2)3,* (a modification of Newton's third law at microcosm). Factually, the interchange of H particle-paths between the adjacent quarks is analogous to that of electron pair, *Note 9(2)2*, along with slight preference, e.g. of uud quarks arrangement in case of proton respect to its reversed handedness ones in our matter Universe.

Example 10(4)1a - As a loose imaginary analogy, the quarks interaction in hadrons can be considered at some likeness to rotating gears (quarks) function in a car (nucleus) gearbox (hadrons). The low range strong force between two neighboring quarks (cylinders) position supposed as transmitted forces (H particle-paths exchange) between the teeth (*A1, A2, A3,* etc.) of the adjacent gears, *Note 10(4)1b.* During the car motion, the rotating gears (quarks) can be displaced with other gears in order to force transmission and changing the car speeds. Moreover, any two adjacent gears may be having different rotating directions (spin).

According to the above statements in a system of *2* quarks (meson) or 3 quarks (baryons) one of the quarks must have an spin at different sign or opposite direction respect to the other ones, *Note 10(4)3.* In addition, a system of *4* quarks due to the lack of symmetry dose not exists. Considering *Fig. 10(1)*, to each quark in addition to its spin related *3* configurations (color), SN_l , SN_m , SN_r and *3* configurations (anti-color), SP_r, SP_m, SP_l mode. Thus, the sum of horizontal components (i.e. perpendicular to the axis of quark rotation or reader page) of vector unit direction related to posipas (or Negapas) is equal to zero. Moreover the sum of vertical components of vector unit of posipas and negapas in three spins mode regarding electric sign and direction of quarks u,u,d such as in proton are equal to zero (neutral color charge).

As it is shown in, *Fig. 10(1)a,* the $-\delta e$ and $+\delta e$ partial charges due to counter-currency mode have main effect in electrical interaction of proton with other charged particles (e.g. electron), *Sec. 4(5), Fig. 4(9).*

Analogous to *Fig. 4(4)* model of moving electron, each of the quark's neutropa unit (e.g. *A, B, C, D,...etc.*) constitutes cells similar to that of the electron. Each cell has own *B* vectors and δl, delta effects that has main interacting behavior as in the cases of electron and proton in case of hydrogen atom formation, *Sec. 9(3)1.* Moreover, the partial charges $-\delta e, +\delta e$ in a nucleon, e.g. proton, or, neutron, leading to an electric dipole moment in it. "The Standard Model of particle physics predicts a tiny separation of positive and negative charges within the neutron leading to a permanent electric dipole moment"[542] *Electric dipole moment*.

Note 10(4)1a- "For example for a proton the masses of two up quarks and one down quark accounts for only about 2% of the mass and 30% of the spin"[33]. According to [314] "In experiments at Jefferson national Accelerator Facility in Virginia, a multinational research team has found that spins of the proton's two up quarks (*u*), are aligned parallel to the overall spin of the proton. However, the same is not true for proton's down quark (*d*)". The three combined quarks system in proton constitute a unique electric

charge e^+ , *Sec. 5(16)4, Remark 5(16)4a*. According to this statement, a proton is constituted of an H hall package, *Sec. 5(16)3a*, of path-length value h , *Sec. 5(16)3g*. The remaining mass and spin related to the H particle-paths, as remainder part of proton, are in correlations with posipa and negapa of proton axeon, i.e. quarks, *Sec. 10(8),* during their passage through this axeon successively as posipa and negapa, and similarly to , *Fig. 4(7)b.*

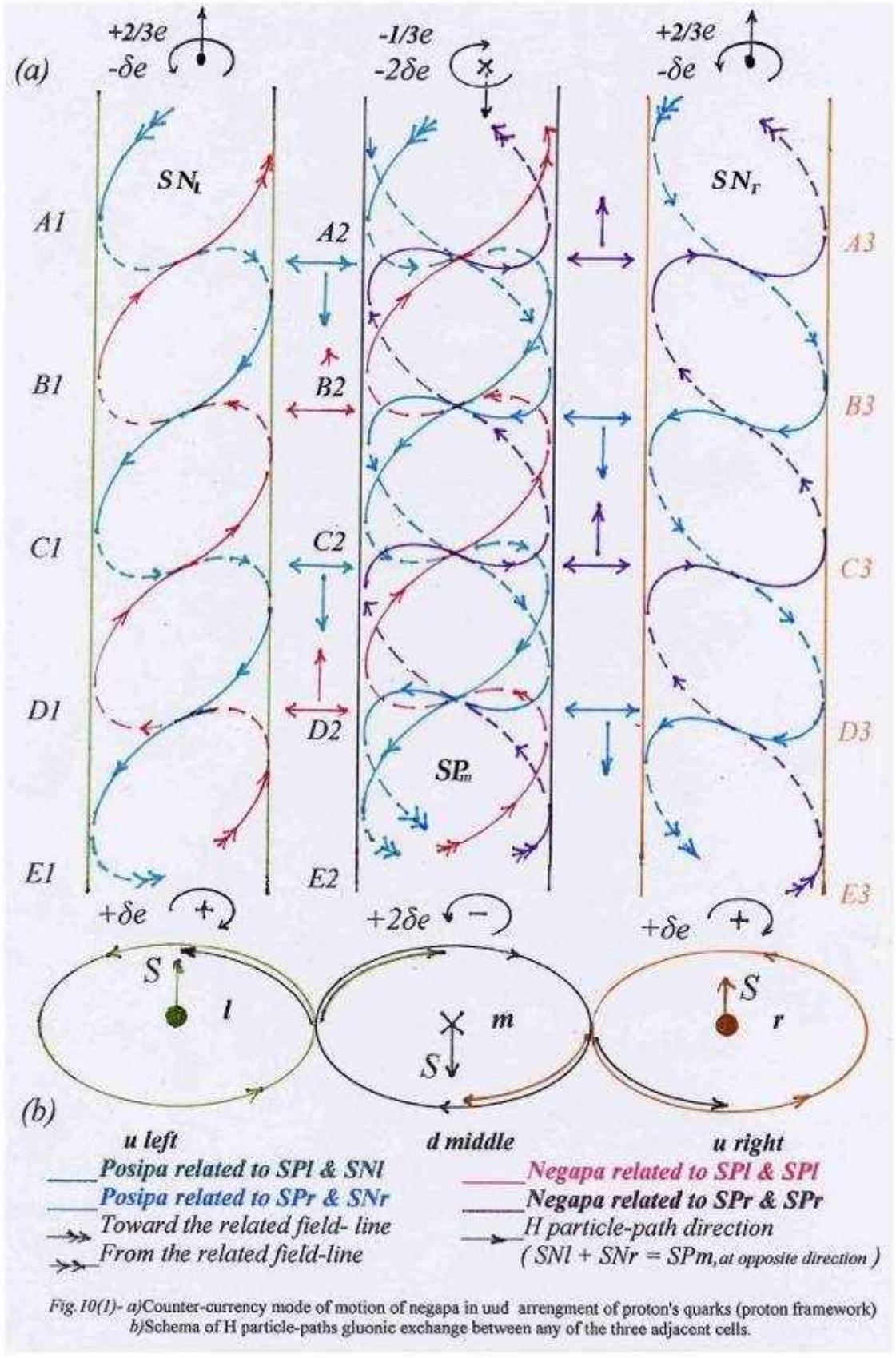

*Fig. 10(1)- a)*Counter-currency mode of motion of negapa in uud arrengment of proton's quarks (proton framework)
*b)*Schema of H particle-paths gluonic exchange between any of the three adjacent cells.

Note 10(4)1b - For the reason of contact exchange of H particle-paths between any two adjacent cells (e.g. *.A1, A2, A3; or, B1, B2, B3,….*), as in case of electrons, *Sec. 9(2), Fig. 9(2),* the color force is low range; please refer to *Fig. 10(1)b*.

Note 10(4)1c– According to [250], *section III, The Bosonic Interaction*" The Exclusion Principle alone does not adequately describe the spin state of the three quarks, in the wave-particle model, the three quarks are spin–tripled"

Comment 10(4)1a – According to *Sec. 4(6)3, Note 4(6)3,* the electromagnetic potential are expanding (i.e. negaton, positon, *Sec. 4(6)4*) by the same analogy of gravity. Therefore, the forces between the electrical charge are diminished by increasing their separating distance r (i.e. $1/r^2$), which in case of quarks in hadrons, there are inseparable groups of H particle-paths that are interchanging between any two adjacent quarks as in, *Fig. 10(1).* In other words, there is a quark-quark bounding that is very much stronger that electron-electron bonding, *Sec. 9(2), Fig. 9(2),* in hydrogen atom, *Note 10(4)1c.* Therefore, there is a flow of groups of H particle-paths as stated above through this coupling nominating reversons, *Sec. 7(5).* "Confinement, which means that the force between quarks does not diminished as they are separated. Because of this, it would take an infinite amount of energy to separate two quarks; they are forever bound into hadrons such as the proton, and the neutron" [412] *introduction*. Factually, the free moving proton, neutron each constituted of *3* quarks are confined in an H hall package of $\hbar$ value, *Sec. 5(16)3g,* with any unit of charge e (or zero charge) and spin $1\hbar$, *Sec. 3(1)2, Eq. 3(27).* Thus, there is a relationship between the stated above universal values in unit of H hall package of a free particle, or, in other words, the fraction of the universal unit value cannot be obtained (or seen) in nature out of an H hall packaging.

Comment 10(4)1b- The electron EM field has expanding type SN_r configuration; while, its axeon has contracting SP_l one. The positron EM field has contracting SP_l configuration; while, its axeon has expanding SN_r one. The proton EM field has expanding SP_r, SP_l, SN_m combined configuration with slight preference of SN_r configuration in SN_m one; while its quarks has contracting SN_l, SN_r, SP_m with slight preference of SP_l one in SP_m configuration. Noteworthy, according to *Note 9(4)6a*, any expanded configuration (or state) emits expandon during stay time interval ΔT, *Sec. 7(4)2f, part A*, along with *G*-expandon ant its electromagnetical *E*-expandon; while, the related contacted conjugate, i.e. *G*-contracton (and *E*-contracton), is nil during a beat, *Comment 10(4)1c*. Therefore, the proton field has a complicated attractive-repulsive effect, *Sec. 9(4)6*, on an electron at a distance contrary to that of the positron which has purely attractive effect on electron. It prevents electron further collapsing on proton. Factually, there is a kind of singularity as in case of reverax, *Sec. 7(5)3b, item II*, or, reverson in case of ground state in a atom, e.g. Hydrogen atom, that has a hard link with $\alpha = \frac{V_0}{c}$ in *Eq. 9(31)* of *Sec. 9(3)1a*. Where, α is the fine structure constant, V_0 the symbolic velocity of electron revolution in the ground state, or, in other words, the common velocity of single direction H particle-paths of that at the ground state. According to *Sec. 5(8)1, Eq. 5(31),* the Schwarzschild radius $l_s = \frac{GM}{c^2}$ in case of reverson, *Sec. 7(5)*, of a mass-body of mass M ; while, in case of atom, e.g. hydrogen atom, the Bohr radius $a_0 = \frac{\hbar}{Z m_e c}.\alpha^{-1}$; where, $Z = 1$ in case of hydrogen atom, m_e the mass of electron.

Comment 10(4)1c- During half of a beat, *Sec. 7(5)3d, part D*, of a particle at expanded mode, *Sec. 8(7)2, part G*, we encounter with type *R* configuration. At contracting mode, the situation is reversed and we encounter with type *L* configuration at the second half of the beat and so on. Based on *Sec. 5(15)2d*, any particle or mass-body has H particle-paths of *SM* configuration that reveals as type *R* and *L* expandons (or cell) successively.

Remark 10(4)1a – From viewpoint of H particle-paths hypothesis. The types up (i.e. SN_r, SN_l), and down quarks, (i.e. SP_m) depend on the mode of *L&R* H particle-paths combination is their. Therefore, the idea to observe the up and down quark as individual has no sense in this respect. In other words, this type of axeon, *Sec. 10(8),* in hadrons or nuclei are ultimately appears after colliding or decay process in the form of related free neutrino, as in case of lepton, *Sec. 10(6).*
Noteworthy, the quarks configuration in proton is the simplest and more stable form than other baryons. As an example, the neutron can be a combination of proton quarks triplets with electron and electron antineutrino axeons that is supposed as one up quark and two down quarks. It will be revealed during the process neutron beta's decay to proton, *Sec. 5(16)9, Example 5(16)9a1*, and so on. As a simple analogy in this field, please refer to *Sec. 10(3)* related to charged pions.

10(4)2- Anti proton's quarks arrangement
Considering *Fig. 10(1), by* interchanging posipa and negapa, i.e. simply by changing their representative colors and right–handed, left-handed arrangements. The antiquarks (antiproton axeon) arrangement in the antiproton will result with related signs; thus, SP_l is the anti quark of SN_r at opposite spin.
According to *Sec. 5(16)9b,* there is a competition between matter and antimatter with dominance of the former in our matter Universe. Therefore, before a quantum measurement (or interaction), e.g., collision, *Sec. 6(2)1a*, force applying, *Sec. 6(2)1b*, there is an indeterministic feature between the stated above quarks and antiquarks group as in case of proton and their mirror image of related antiquarks and quarks group as in case of antiproton respectively. In other words, there is a competition (or an equilibrium state) between H particle-paths of three SN_l, SN_r, SP_m quark configurations of *Sec. 10(4)1,* and three

SP_l, SP_r, SN_m configurations of present section, i.e. a colorless state. These six configurations depend somehow on three-color charges and three complementary color charges of quarks and antiquarks. Generally speaking, there is a competition between proton and antiproton with the preference of the former one; please refer also to *Sec. 8(7), Example 8(7)2,* and *Sec. 8(9).* Contrary to weak dominance of quarks and antiquarks group of matter Universe respect to that of the antimatter one, during a quantum measurement there is an equal probability between the two groups that manifest in their related internal exchange as color charge carriers, i.e. gluons*, Note 10(4)2a*.
Moreover, model of two photons (single direction H system) at opposite directions and spins (as in annihilation process) will result by the posipa and negapa combination of SP_l and SN_r configurations at opposite spin. (Refer to *Sec. 4(4), Fig. 4(8)*, for photon model); please refer also to *Note 10(1)1.*

Note 10(4)2a- The group of H particle-paths, e.g. gluon, intra-changing between two adjacent quarks bounding is one of the main characteristic of fermion's axeon as a reversible counter-current H particle-paths with SP configuration that differ from single direction H particle-paths such as in photon's axeon with SM configuration. Please refer to *Sec. 3(1)2, Figs. 3(4), 3(5)* in this regards. The groups of H particle-paths are exchanging between quarks in the framework of reverson, i.e. reverax, *Sec. 7(5)3b, item II*). According to *Sec. 7(5),* any reverson transfer between two quarks of opposite spins at stay times ΔT, *Sec. 7(4)2f, part A*, is along with handedness reversal of related quarks. The reversons in the latter case are more energetic than that are interchanging between coupled electron of opposite spins in chemical bonding, *Simulation 7(4)3, E2a*. From viewpoint of H particle-paths hypothesis, the aggregated contractons, *Sec. 7(5)3d, Part B*, in *G*-reversons in case of nuclei are comparable with the force carrier gluons in modern physics. Moreover according to Fig. 10(10, the flavor of quarks are interchanging successively, i.e. $u \to d \to u \to \ldots$ during interchange stay time. Noteworthy, in a nucleus the adjacent neutron proton interchanges their flavors. Therefore, proton converts to neutron, and neutron to proton successively. According to *Fig. 10(1),* the down quark of SP_m configuration is heavier than up quark of SP_l or SP_r configuration. The free neutron of two down quarks is non-stable. Noteworthy, one of the d quarks of free neutron is correlated, *Sec. 8(9),* to u quark of its adjacent proton in nucleus up to an interaction or beta decay. According to *Comment 7(5)3d, B3*, a virtual W boson picks up its axeon from the d quark during the beta decay. Thus, the baryon is converted to a stable free proton with u, d quarks as is shown in *Fig. 10(1).*

10(5) - Electron-Neutrino arrangements

Referring to *Fig. 4(4),* the neutropa arrangement with S_P configuration, *Sec. 3(1)2*, along x-axis is considered as moving electron axeon, *Sec. 10(8),* that is responsible to partial charges $-\delta e$ and $+\delta e$ formation. Moreover it has main effect in force formation due to electromagnetic interactions with the other moving charged particles *Sec. 4(3)1, Fig. 4(5)*. Similarly, the quarks configuration *Sec. 10, Fig. 10(1)*, of proton can be regarded as neutropa arrangement (proton axeon and its partial charge $-\delta e$ and $+\delta e$ has main effect in electrical interactions of proton with other charged particles, *Sec. 4(5), Fig. 4(9).*

On the basis of the above statements, by analogy of striking photon in Compton effect, *Sec. 3(1),* we can supposed the electron neutrino υ_e in its bonded state in electron structure, as neutropa arrangement of an electron at rest state (electron axeon) with S_P, configuration, *Sec. 3(1)2; Fig. 3(4)a.* In other words, electron has no rest state as in the case of mass-bodies and may have random back and forth common motion, i.e. according to uncertainty principle, *Sec. 7,* jiggling (*Simulation 8(7)2, E5a, item23*) around its supposed rest point, *Note 10(5)1*, along with its partial charges $-\delta e$ and $+\delta e$ as in *Fig. 4(9).* In addition, this partial charge has main effect in electrical force part in the electromagnetic interaction of electron with other charged particles. Analogous to electron, muon and tau particles has own associated neutrino in the bonded state as their internal axeon structure. Similar cases will be occurred for positron, antimuon, antitau particles and their associated antineutrinos as their internal axeons. Please refer also to *Sec. 5(16)3b, part G, item A*.

Note 10(5)1- According to *Note 7(1)2*, a particle at micro level changes its position during time intervals ΔT successively. In other words, there is a successive transfer between adjacent positions of reversed handedness within partial time intervals.

10(6) - Lepton number

"In any process, the lepton number for electron-type leptons, muon-type leptons, and tau-type leptons must each remain constant"[4] *Section 56-3*.
Minus muon decays [14], as following:

$$\underset{type\ R}{\mu^-} \to \underset{R}{e^-} + \underset{L}{\overline{\upsilon_e}} + \underset{R}{\upsilon_\mu} \qquad 10(8)$$

Please refer to *Note 5(16)8b1,* and *Simulation 8(7)2, E5a, item 12.*
According to *Sec. 10(5),* the *Eq. 10(8)* can be seemed, as:

$$\underset{\upsilon_\mu}{\mu_s^-}, \to \upsilon_\mu + W^- \qquad 10(9)$$

W-minus subsequently decays to:

$$W^- \to \underset{\upsilon_e}{e_s^-}, + \overline{\upsilon_e} \qquad \textit{Remark 10(6)1} \qquad 10(10)$$

μ^- emits its bounded neutrino [or axeon, *Sec. 10(8)*], υ_μ during its decay and converted to W^- (or μ_s^- muon shell, *Comment 10(6)1*) that is a pseudo-particle, *Secs. 2(7), 6(2)5,* due to α <0 (emission case) with no internal axeon or better to say negative axeon, *Sec. 10(8);* since, W^- decay to electron (with its bounded υ_e neutrino and e_s^- shell) and free moving electron anti neutrino $\bar{\upsilon}_e$; moreover, W^- can be regarded as a boson that "exchanges the forces acting on matter"[64], *part 1*.

During the decay, υ_μ released from its bounded state in μ^- structure and $\bar{\upsilon}_e$ is released due to electron $\left(e_s^- + \upsilon_e\right)$, *Remark 10(6)2,* formation.

The similar result will be obtained during π^- decay:

$$\pi^- \rightarrow \begin{matrix}\mu_s^- \\ \upsilon_\mu\end{matrix}, +\bar{\upsilon}_\mu + \text{ photon}, \qquad \textit{Note 10(6)1} \qquad 10(11)$$

Thus the μ^- lepton number conserved before and after decay, *Note 10(6)2*, or, in other words, we can assume lepton number as the related to neutrino and antineutrino (free or bound) algebraic number balance in the two sides of equation. Please refer also to *Sec. 5(16)8b* in this regards.

As a result, leptons other than neutrino group (e.g. electron, muon, and tau and its related antiparticle) are constructed of two parts as follows:

I) Charged bosonic part, with the same charge sign as lepton, i.e. shell.

II) Neutrino part as its axeon (neutropa arrangement) with no charge, or, neutrino in case of related antilepton, *Comment 10(6)2*.

When the neutrino part leave the lepton, i.e. α <0 *Sec. 2(1)1, Eq. 2(7), Sec. 2(7),* and the Bosonic part *(I)*, or, Boson has the same speed as if α >0 (absorption case), *Eq. 2(7)* and it is seemed that the conservation law of energy lost its validity. However, this not true, the total H particle-paths number of the whole H system before, after emission and during the decay process remain constant, i.e. the total energy conserved.

The bosonic part is unstable and is converted to a lighter lepton (i.e. combined lepton shell with its own neutrino axeon) and it's related anti neutrino released accordingly, *Comment 10(6)3*.

Note 10(6)1- "Since the negative pion , π^- , has spin zero, the electron and antineutrino must be emitted with opposite spins to preserve net zero spin; but antineutrino is always right-handed, so this implies the electron must be emitted with spin in the direction of its linear momentum (i.e. also right-handed)"[150].

Note 10(6)2- In many theories of physics beyond standard model neutrinoless double beta decay can occur with the emission of new bosons, so called Majorons.

$$2n \rightarrow 2p + 2\bar{e} + \phi \qquad 10(12)$$

$$2n \rightarrow 2p + 2\bar{e} + 2\phi \qquad 10(13)$$

The Majoron is the Nambu-Goldstone boson associated with spontaneous breaking of the *B-L*-symmetry and so generates Majorana masses of neutrino [393]. This possibility may be relevance in nature if neutrino masses are lepton number violating. The associated boson, the Majoron, has phenomenological consequences that have been studied in the context of a variety of models [394] *Section 1.*

Comment 10(6)1- Minus muon, μ^- , can be regarded of two parts, its axeon υ_μ , *Sec. 10(8),* and its shell, μ_s^- , as a particle without axeon [i.e. pseudo-particle, *Sec. 2(7)*]. In other words, $\alpha < 0$, i.e. a pseudo-particle comparing to a true one at equal velocity. Thus, its energy is equal to that of true particle at the same speed (with axeon) minus energy of the axeon. Therefore, its total energy computed by usual way, i.e. mass-energy conversion and velocity, is lower than related true particle at the equal velocity as if the conversion law of energy is violated; please refer to *Sec. 4(3), Fig. 4(4),* to have a view of electron shell and its axeon during its motion.

Comment 10(6)2 – Referring to *Sec. 4(3)3, Fig. 4(7)b*, the H particle-paths axeon's (neutrino part) have reversible motion, or, in other words, it has non-zero mass as its related neutrino; please refer also to *Sec. 10(8).* According to [272], challenges to the standard model "Super-Kamionkande published results indicating neutrino oscillation, a massless neutrino cannot oscillate, so this observation implied to the existence of non-zero neutrino masses.

Comment 10(6)3 – According to [303], particle physics," The boson is decaying into a neutrino-antineutrino pair as predicted by the Standard Model". Therefore, neutrino and antineutrino in their bound stage can be regarded as related particle axeon, *Sec. 10(8),* respectively; evidently, one of the neutrino (or antineutrino) is bounded in the related particle (or antiparticle) as its axeon.

Remark 10(6)1- According to *Sec. 6(2)6b, part B*, a *W* boson can also be regarded as a particle shell that is composed of compact expandons. Please refer also to *Sec. 5(16)2c, part c*.

Remark 10(6)2 – In $\left(e_s^- + \upsilon_e\right)$ complex the electron neutrino axeon υ_e cannot be separated from electron shell e_s . It is analogous to quark in hadrons. In fact e_s is constituted of right-handed H particle-paths. Therefore, the electron neutrino axeon υ_e has left-handed characteristic.

10(7) - A strange Suggestion

Considering:

I) Table 4(1), the seventh column, (dipole), and *Eqs. 4(8), 4(9)* related to moving charged particle (e.g. electron).

II) If a photon has a high amount of energy more than 1.02 *MeV* and the sticking nucleus is heavy enough, the collision may result in the pair production of an electron and a positron.

According to the stated above statements, as two particles at low speeds transformed into photons at c speed and a high-energy photon (zero rest mass) undergoes transformation into two particles at lower speeds (e.g. $v << c$ *paragraph II*). There is an intermediate state that a photon with c speed is strike with a particle, *Sec .3,*(Compton effect), and transformed to a counter-current posipa and negapa (i.e. particle axeon, *Sec. 10(8)*, at v speeds) as in case of moving electron paragraph I. Simultaneously we can suppose that a pair of semi particles with partial and opposite electric charges, $-\delta e$ and $+\delta e$, *Eq 4(8*), [refer to *Sec. 3(1)2*] and increased (partial) masses are formed in moving electron as a dipole. Thus, a moving electron or fundamental particles is a media of transforming the striking photon, *Sec. 3(1),* that give birth to new fundamental particle at appropriate energies during a process of collision with other particles. Therefore, the H particle–paths of entered photon transformed to H particle-paths of new fundamental particles; moreover, photon before measurement process can be regarded as counter-current H particle-paths, *Comment 8(1)3b.*

Note 10(7)1 – When an electron and positron collide at high energy, they can annihilate to produce a pair of charm quarks (semi particles).

According to *Eqs. 2(22), 4(8):*

$$\alpha = \frac{n_{\alpha e}}{n_{0e}} = \frac{N_{\alpha e}}{N_{0e}} = \frac{\delta e}{|e|} \qquad 10(14)$$

Where:

- $N_{\alpha e}$ The number of irreversible H particle-paths *Eq. 3(10)*, related to the total initial number, N_{0e} of the H particle – paths of a moving electron, *Eq. 2(35),* and $n_{\alpha e}$, n_{0e} are their related frequencies equivalent respectively.

Therefore, α , *Eqs. 2(7), 2(22)* is equal to the ratio of the magnitude of generated partial charge respect to the magnitude of electron charge, or, partial charge related to the unit of charge.

Thus, the absorption of a photon by an atom (visualized as semi particles) is similar to the case of the moving free electron accompanied by the appearance of partial charges and masses accordingly. In return, the semi particles annihilation generating photon that emits from excited atom.

10(8)-Particle axeon

Axeon is a collection of neutropas arrangement (constituted of counter-current H particle-paths, *Sec. 3(1)2*) inner a fundamental particle considering the motion of remaining H particle-paths respect to that. Thus, the axeon can be regarded as an internal pivotal skeleton of a fundamental particle in respect to its surrounding H particle-paths behavior; please refer to *Sec. 2(7), Example 2(7)1*. According to *Sec. 4(3)3, Fig. 4(7)b,* the propagation of the electromagnetic field of $B_4(\overline{e})$, i.e. posipa or negapa field, photon radiation of interacted charged particles, *Fig. 4(5)*, can be arranged by its central axeon, i.e. neutropa, along x_2x_1-axis of a particle. On the other hand the electromagnetic field background energy is merely related to negapa or posipa as half energy of a photon, i.e. negapa & posipa combination, *Sec. 4(4).* In fact, the field growth both in gravitational and electromagnetical, are similar at the same rate of expansion and performed according to expanding surface, *Sec. 5(4),* except that the electromagnetic field is constituted of single direction H particle-paths as singlet. Moreover, the gravitational one has back and forth characteristics according to counter-currency mode of motion, *Sec. 3(1)2*, *Sec. 4(4), Fig. 4(8)*, and *Sec. 5(16)1b, part A*, by considering the fact that the field is expanded form of the mass, *Note 2(1)3b*. Each of these expanding surfaces carries the history (or information) of the particle behavior along with the trace of its related axeon and remaining H particle-paths; moreover, the axeon of the field, by loose analogy can be visualized as vacuum polarization effect (or fluctuation) of the field according to quantum theory. As a result, all the particles, atoms, electromagnetic waves, oscillating motions have their intrinsic axeons at the ground state of quantum level "nominated background axeon". Please refer also to *Sec. 5(16)3i,* and *Sec. 8(2)3, part A.* According to *Sec. 7(5)3b*, the axeon of a particle, electromagnetical wave, a harmonic oscillator with one degree of freedom, *Remark 5(16)3c1,* e.g. electron pair in a chemical bonding, the Schwarzschild surface of a mass-body, is the border of a singularity (or ground state). It shields the abstract vacuum, *Sec. 5(16)3h,* of reversons within mass medium, the H hall package tunnel, *Comment 5(16)2a1,* in spatial medium, *Sec. 7(4)3,* as singularities, *Sec. 7(5)3b*.

Resuming axeon is confined in an H hall package, *Sec. 5(16)3a*, of h value; thus, cannot be existed out of the latter. Axeons consist of counter-current H particle-paths of SP , or, SN configurations, *Figs. 3(4)a, b*, related to fermionic group. In contrast to boson of SM configurations, *Fig. 3(4)c*, relating to bosonic group. The lepton has internal intrinsic axeon of neutrino-base, *Sec. 10(6).* Hadrons such as proton and neutron have quarks as their intrinsic axeons. Molecule, e.g. hydrogen molecule, has its intrinsic axeon due to vibrational motion of its electron at ground state, *Sec. 8(2)3, Note 8(2)3a*. This implies that molecules are

not completely at rest, even at absolute zero temperature. Noteworthy, axeon has the role of emitting or absorbing boson, e.g. photon. As an example, quarks related to fermionic structure in hadrons may exit (or absorb) a gluon of bosonic structure similar to the case of lepton, *Sec. 10(6).* Resuming axeon is confined in an H hall package, *Sec. 5(16)3a*, of h value; thus, cannot be existed out of the latter. Axeons consist of counter-current H particle-paths of SP , or, SN configurations, *Figs. 3(4)a, b*, related to fermionic group. In contrast to boson of SM configurations, *Fig. 3(4)c*, relating to bosonic group. The lepton has internal intrinsic axeon of neutrino-base, *Sec. 10(6).* Hadrons such as proton and neutron have quarks as their intrinsic axeons. Molecule, e.g. hydrogen molecule, has its intrinsic axeon due to vibrational motion of its electron at ground state, *Sec. 8(2)3, Note 8(2)3a*. This implies that molecules are not completely at rest, even at absolute zero temperature. Noteworthy, axeon has the role of emitting or absorbing boson, e.g. photon. As an example, quarks related to fermionic structure in hadrons may exit (or absorb) a gluon of bosonic structure similar to the case of lepton, *Sec. 10(6).* Factually, the axeon can be regarded as reverson, *Sec. 7(5),* of single direction H particle-paths in a moving particle, or, mass-body. Thus, the counter-current H particle-paths of the axeon shields the abstract vacuum, *Sec. 5(16)3h,* of this single direction reverson; please refer also to *Comment 5(9)3d2*.

11- Statistical behavior of H particle-paths.

11(1)-General aspect

Supposing an ideal gas with N_t identical particle contained in a box. From view point of H particle-paths each particle consist of N_o, *Eq. 2(35)* H particle-paths (m_o rest mass) moving in a forward-backward motion, *Sec. 1(2),* or, in other words, reversible intrinsic internal motion accompanied by vibrational, rotational plus single direction ones, i.e. translational motion, the latter one can also be considered as reversible on the whole space of the box. According to Mirror Image Effect, *Sec. 6(2)3*, the H particle-paths of the box walls are in steady exchange with that of colliding gas particle. In other means, a specified amount of H particle-paths in the form of single direction return energy, E_R , *Sec.2(2), Eq. 2(44),* kinetic energy, *Eq. 2(40)* and free quanta or photons interchanged with that of the walls and colliding particles, as if the gas particles acts as carrier of these single direction H particle-paths.

At any time interval for each of the gas particles, there will be a wave-like pattern as in *Fig. 4(4),* in its H hall quantized package, *Sec. 5(16)3a,* that is extended to the wall surfaces of the box, *Sec. 8(2)1*. In other words, the number of single direction H particle-paths, N_β , *Eq. 8(6),* [i.e. contracted or overlapped form of N_α , *Eq. 2(22)*] is specify by box dimension according to quantum theory as its contracted or overlapped form N_β , in each H hall quantized package, *Sec. 5(16)3a.* Thus, the box volume is divided by H hall quantized packages, *Sec. 8(2)2,* and *Sec. 7(4)3, E2*. In fact, a particle with N_α single direction H particle-paths energy state of that. Moreover, the particles frequencies (or velocities) are distributed according to energy states distribution law of these wave-like particles.

On the basis of statistical distribution two kinds of interactions take place as following:

I - Interaction based on the quanta absorption or emission by the walls of the box and gas particles. Moreover, at this case the numbers of gas particles that are subjected to Bose distribution remain unchanged; while, the number of quanta is not a constant quantity, since quanta may be absorbed or radiated; please refer also to *Comment 8(1)3b.*

II - Interactions based on the collision of gas particles and the box walls according to *Mirror Image Effect*; thus, the H particle-paths of the wall interchanged with that of particles as impulsion, *Sec. 6(2)3,* and *Note 11(1)1.*

At the two above cases, groups of H particle-paths in the form of quantas (of path-length value h confined in H hall package) exchange between the box's walls, and gas particles till to reach an equilibrium based on Mirror Image Effect. In other words, the total flux of single direction H particle-paths through an imaginary cross section *S* of the wall, i.e. incident and reflected ones, *Sec. 6(1), Eq. 6(1)*, are equalized through an equilibrium process.

In case of Fermi-Dirac distribution at absolute zero each collection of pair of particles with non-integer spin (e.g. electron) are extended to the walls of the box as if the whole particles system constituted a unique H system, i.e. zero entropy. In order to have a conception of moving electron and Pauli Exclusion Principle refers to *Figs. 4(4), 9(2),* respectively. According to Pauli principle, *a pair of electron at opposite spin occupies Sec. 9(2), any state or cell of the box* and the next two electrons cannot enter the same cell. Thus, the next cell must differ from the first one according to the uncertainty principle, *Sec.7*, by a factor of $\Delta p_x \Delta p_y \Delta p_z$ and so on [36], *Remark 11(1)1*. Therefore, H particle-paths interchange between the cells in such a manner to conserve the above conditions and ultimately reflect back, i.e. interchanged with that of the box walls.

Generally, at normal temperature each of the independent particles of the ideal gas has its own path-limit, Γ , *Eq. 1(3),* of h value, *Sec. 5(16)3g*, and can be regarded as a single H system (an H hall quantized package, *Sec. 5(16)3, Remark 5(16)3a1*). Supposing *N* is the total number of the particle of the whole system (e.g. box); therefore, the total path-length is equal to $N\Gamma$ of total path–length value *Nh*, *Sec. 8(2)2*. Indeed, we can specify at this case to each of particle of path-limit Γ (or path *Sec. 5(16)11*) individual component of total wave function of the system. Now supposing the whole system is cool down by an external medium, during this process *N-1* quanta with the total path *(N-1)* Γ , exit from the system and the total path of collection the particles at absolute zero, *Note 11(1)2,* become equal to path-limit Γ . It is based on the consistency of the total path-length, *Sec. 2(1), Eq. 2(26), Fig. 2(4),* in a uniform medium. Thus, an unique H system (or H hall quantized package) with a path-limit, Γ , *Sec. 5(16)3a,* and zero entropy obtained. At this case, only a huge wave function can be specified for all of the particles, *Note 11(1)3.* As a result, according to the above statements, a wave function per path-limit Γ is confined in an H hall package; thus, a close link between the concept of path-limit Γ of the particles and related entropy is revealed. In other words, by energy increasing of the whole H system, the total number of quanta or single direction H particle-paths is accompanied by total number of path Γ increment; moreover, the entropy of the system increases accordingly; please refer to *Sec. 5(16)7a.*

As the result, the relative number of Γ path-limit of the particles in a low dense gas is higher than the dense one for the reason of lower interaction or H hall packages overlapness.
In a free expansion process of gas expansion into a vacuum, the single direction H particle-paths of the quanta and moving particles enter in a larger volume i.e. to a low dense medium, and each particle of the initial system tends to a low interacting independent H system, thus having its own path. Therefore, the total number of non-overlapped H hall packages each of path-limit Γ, increases or in other words entropy increases. Therefore, according to *Sec. 5(16)3a,* through increasing of H hall packages, the space expands, *Secs. 5(16)3, 5(16)7*, along with time's arrow. As a result, entropy increases as time increase along with space expansion.

Note 11(1)1- The case *I* can be considered as a special case *II*.

Note 11(1)2- At absolute zero, the H particle-paths of an H system with rest mass become purely reversible excluding single direction one, *Sec. 1(3).* At this stage merely, the H particle-paths of particles is exchanged at c speed in a purely reversible mode of motion.

Note 11(1)3– According to [250] *section II, Local Charge Energy Field*," At *MIT*, the *BEC* (Bose-Einstein-Condensate) is described by the Ketterle group as a giant matter wave". On the basis of H particle-paths hypothesis, this giant matter wave can be considered as a unique H system, *Sec. 8(5).*

Remark 11(1)1:

1) Each cell irrespective of its energy level has a constant path-length of h value, *Sec. 5(16)3g*, during its occupation by a particle (or particles).
2) In case of fermions, each cell can accept two particles of opposite direction path-lengths, but at the same type, i.e. type L_c, *Sec. 5(16)11*. Factually, according to *Sec. 9(2),* a pair of electrons in their fermionic aspects occupies only a cell of opposite direction path-lengths of type L_c. In other words, there is a counter-current motion of H particle-paths according to *Fig. 9(2)* in case of pair of electrons.
3) In case of bosonic particles, each cell accepts particle of the same energy, and path-lengths of the same direction.
4) A many particle system in a box constitutes a unique H system, *Sec. 8(5),* of total path-length value h just during an interaction (or measurement, *Sec. 8(7)2*) of external measuring device the path-lengths as stated above in a cell are revealed.

11(2)-Degree of expansion-contraction

A system occupies the volume of some cylinder with a movable piston, the force, *F, Sec. 6(2)1b,* acting on the piston can be regarded as H particle-paths transmitted through surface *S, Sec. 6(1), Fig. 6(1),* in a time interval Δt of force application. Thus, the work done dA, during dx piston displacement is proportional to the number of H particle-paths transferred during time interval Δt, *Sec. 6(1), Eq. 6(1),* thus:

It can be seen that the total energy variation $d\bar{\varepsilon}$ of particles in the piston-cylinder body system is made up of the work dA done by the body, (i.e. energy decreasing) and the quantity of heat dQ transmitted by one external body by purely contact interaction without any particle interchange (i.e. energy increasing) as:

$$d\bar{\varepsilon} = dQ - dA \qquad 11(1)$$

$$dA = F.dx = \frac{F}{S}.Sdx = PdV \qquad 11(2)$$

Where, *P* is gas pressure and dV is the volume increment of the system respectively. In other words, single direction H particle-paths in the form of photon, quanta, or through collision, external force, *Secs. 6(2)1,2,* of the particles transmitted to the body.
If the volume of the body do not varies, then $dA = 0$, or, in other words, we encountered with mutual transfer of single direction H particle-paths as quanta, through the surface *S* of the piston until to reach an equilibrium, *Eq. 6(1).* Therefore, energy is imparted to a system without change of its external parameter; thus:

$$dQ = d\bar{\varepsilon} \quad , Q = \Delta\bar{E} \ (V = \text{Constant}) \qquad 11(3)$$

According to the above statements and Bose distribution of *N* bosonic particles in a volume *V* of a rigid box or vessel (potential energy is infinite, $U = \infty$ at its walls), the space related to each interacting particle, V_{BP}, supposing the box is insulated; thus:

$$V_{BP} = \frac{V}{N} = \frac{2^{1/2}\pi^2 h^3}{m^{3/2}} \left(\int_0^\infty \frac{\sqrt{\varepsilon}\, d\varepsilon}{e^{\frac{\varepsilon-\mu}{\theta}} - 1} \right)^{-1} = V \left(\int_0^\infty \frac{d\, g_\varepsilon}{e^{\frac{\varepsilon-\mu}{\theta}} - 1} \right)^{-1} \approx \frac{\theta}{P} = k\frac{T}{P} \qquad 11(4)$$

Where:

ε - Related to a group of particles of energy range $\varepsilon, \varepsilon + d\varepsilon$ at state weight $d\, g_\varepsilon$.s

μ - Thermodynamic chemical potential related to a single particle

k- Boltzman constant

θ - Statistical temperature, *Sec. 11(3).*

P- Gas pressure

According to definition of V_{HP}, i.e. expansion related to a free particle, *Eq. 5(70)2:*

$$D_{EC} = \frac{V_{BP}}{V_{HP}} \qquad 11(5)$$

Where, D_{EC} is degree of expansion-compression of H hall quantized package, *Sec. 5(16)3a,* in case of N Bosonic particles in volume V.

Considering mass-energy conversion, the volume V_{BP} is proportional to inverse mass equivalent related to reversible motion of single direction H particle-paths of the N particles inside the body; moreover, at the case of constant volume, V_{BP} is constant.

11(3) - Statistical temperature θ

Assuming N particle of ideal gas contained in a box of volume V at pressure P, the mean kinetic energy $\bar{\varepsilon}$ per particle is obtained according to Boltzman statistic:

$$\bar{\varepsilon} = \frac{\overline{p^2}}{2m_0} = \frac{3\theta}{2} \qquad 11(6)$$

Where, $\overline{p^2}$ and m_0 are the average square momentum and rest mass of particle respectively.

According to *Eqs. 2(30), 2(35), 3(10), 11(4),* we have:

$$\theta = \frac{2\bar{\varepsilon}}{3} = \frac{m_0\overline{\alpha^2}}{3}c^2 = \frac{N_0 a_1 h\overline{\alpha^2}}{3} = \frac{a_1 h\overline{N_\alpha{}^2}}{3N_0} \qquad 11(7)$$

Where:

θ - Statistical temperature.

N_0 - The total initial H particle-paths of the particle.

$\overline{\alpha^2}$ - The average of square of single direction H particle-paths of the particle to the total initial H particle-paths ratio.

$\overline{N_\alpha{}^2}$ - The average of square of total single direction H particle-paths of the particles.

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

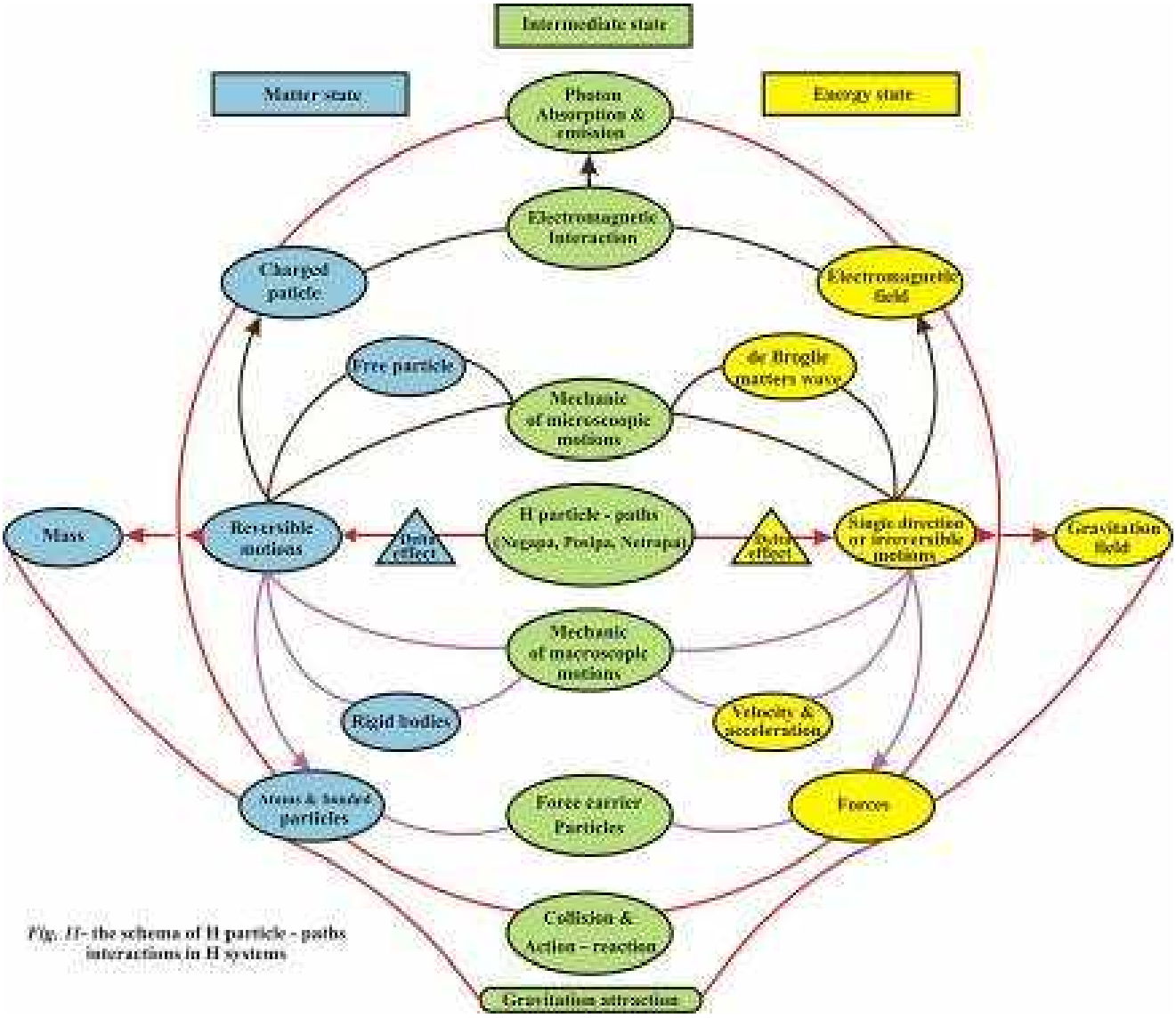

Fig. 11- the schema of H particle - paths interactions in H systems

In *Fig.11*, the blue color can be related to contracting H particle-paths of SP_1 configuration e.g. in mass medium, *Sec. 7(4)3, part D,* the yellow color to expanding H particle-paths of SN_r configuration related to e.g. spatial medium, *Sec. 7(4)3, part A*. The green color to H particle-paths of *SM* configuration, or in case of H particle paths related to both expanding and contracting configurations at once.