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Unification of Physics, premises and basic results

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Abstract

It is shown that the *measured* constancy of *c* depends on two reasons**:** the first is the equality $c = u$, with $u = \sqrt{-2U}$ the *total* escape speed (from all the masses in the universe) and *U* the *total* gravitational potential, practically constant on Earth**;** besides, as the said equality implies the massiveness of the light, we inferred its structure as composed of *photons* having parameters λ (their length) and frequency ν (their number, of the same ray, flowing in a time unit). The 2nd reason is due to the measurement system (*R*) of *c*: the incident photons (of one ray), parameters c_0, λ_0, ν_0 referred to their source *S*, are *absorbed* by an impacting *electron* (belonging to *R*) which takes on, see **Fig. 5**, a radial velocity **w**, whose value is represented on Fig. 2(**a**) by w_i**;** thus, during the impact, due to Doppler effect, the photons frequency referred to the *electron* becomes $\nu_e = \nu_0(1 - \beta_e)$ with $\beta_e = w_i / c_0$**.** Then, after the absorption/emission time, the frequency of the photons re-emitted by the electron (acting as a new source) and hitting *S* will also be $\nu'_S (= \nu_e) = \nu_0(1-\beta_e)$, and if *R* and *S* are at reciprocal rest, the frequency outgoing from *R* is also $\nu_{R\,out} = \nu_0(1-\beta_e)$**;** in addition, the conservation of energy applied to the incident photons and the moving electron, see § 1.4, gives $c_{R\,out} = c_0$, yielding $\lambda_{R\,out} = \lambda_0/(1-\beta_e)$. Finally, if *S* has a velocity $\mathbf{v}_{RS}$ with respect to *R*, then $\nu_{R\,out} = \nu_0(1-\beta)$ with $\beta = \beta_e \pm \beta_S$, where $\beta_S = |\mathbf{v}_{RS}|/c_0$ giving $\nu_0(1-\beta)\lambda_0/(1-\beta) = c_0$ whichever are the values **w** and $\mathbf{v}_{RS}$. Hence the *measured c* turns out to be invariant, on Earth, without the support of the Relativity Theory.

Then, in order that each admitted impact photons-electron has to move the electron toward higher orbits, we have considered the electron charge as a point particle (representing the photon-electron impact point) fixed on the electron surface, facing the atom nucleus during the electron orbits, **see Fig. 5**. On these bases, on H atom, we found, among other results, that the number of the electron circular orbits is *n* = 137; the electron ground-state orbital speed is *exactly* v = *c*/137; the electron charge ground-state orbital speed is $v_0 = \alpha c$ (with α the fine structure constant), while the quantum numbers are found to be related to the number of admitted photons along each electron circular orbit. As for the claimed fall of *circling* electrons into their nucleus due to their *supposed* emission of photons**,** we found that electrons are emitting the previously absorbed photons *only during the spiral path* from higher orbits toward their ground-state as shown on § 2.4.1.

Keywords: Total escape speed, Time dilation, Harvard tower experiment, Photoelectric effect, Compton effect.

Introduction

This work is based on the following three premises:

1- Equality *c* = *u*. We found that the *total* escape speed *u*, given a value of the universe mass shared by many physicists, tends to *c*, hence constant on Earth. This equality has also a cosmological reason: if *c* > *u*, all the masses, following the photons mass moving toward the infinity, would be dispersed from each other; if *c* < *u* all the masses would collapse, while, for *c* = *u*, the mass of photons will ensure an endless balance between dispersion and collapse. In fact, as shown on § 1.6, the neutrinos are also necessary for this balance.

2- A structure of the electron where its charge is not distributed all over the electron mass, but it can be considered as a point particle which becomes the photons-electron impact point, where photons are absorbed and released.

3- A massiveness of the light, composed by photons moving along rays. The impacts photons-electron, so to provide the electron with a radial velocity **w** toward higher orbits, must happen along the radial direction *electron charge→electron center,* see **Fig. 5**, § 2.1; this requires a longitudinal shape of the photons which, in order to hit the electron on its charge, must have their *front* provided with a positive electric charge (their *tail* with an equal negative one).

In the first part we show how the *measured c* is invariant whatever is the relative speed between the light source and the measurement system; how *c* varies according to the potential; how the claimed *time dilation* observed by the atomic clocks (like every photons source) also depends on the potential; how the gravitational redshift is due to the variation of *c* during the path of the light. On chapter 2, we show that the Bohr model, modified by our electron structure, is still valid; as for the quantum numbers, on H atom we found that the number of electron circular orbits is *n* = 1, 2…137 while n^2 is the number of admitted photons during two electron circular orbits while, for instance, *n* = 1, 2,… 223 as for the free atom of sodium. The photoelectric effect, at the threshold frequency, requires ≅ 200-360 photons depending on the specific work function, while on Compton effect only one photon, at a specific frequency ν_1, see Eq. (110), is sufficient. Finally, a specific experiment would show that the *compensation* velocity (to restore the resonance source-detector at different height) has *opposite direction* with respect to the one predicted by RT.

Part 1 – Invariance, on Earth, of the *measured* speed of light

1.1 Total gravitational potential *U*, its related total escape speed *u* and equality *u* = *c*.

The gravitational potential *U*, due to one mass *M*, acting in a point O with s_O the distance *M*-O, is $U_O = -MG/s_O$ which is a scalar quantity and therefore, considering two masses, we have

$$U_{1,2} \equiv U_1 + U_2 = -\left[\left(\frac{M_1 G}{s_1}\right) + \left(\frac{M_2 G}{s_2}\right)\right] \Longrightarrow U_{1,2} \equiv -M_{1,2}G/s_{1,2} \quad (1)$$

with $M_{1,2} \equiv (M_1 + M_2)$, and where $s_{1,2}$ is the weighted distance from the considered point to the only mass $M_{1,2}$ giving the same potential as the actual masses M_1 and M_2; in fact,

$$\frac{M_{1,2}}{s_{1,2}} = \left(\frac{M_1}{s_1}\right) + \left(\frac{M_2}{s_2}\right) \Longrightarrow 1/s_{1,2} = (\alpha_1/s_1) + (\alpha_2/s_2), \text{ (with } \alpha_n = M_n/\Sigma M_n). \quad (2)$$

Considering all the masses, the total potential U, acting in a point at distance s_n from each mass M_n, can be written

$$U \equiv \Sigma U_n = -\Sigma M_n G/s_n = -M_u G/s_M \quad (3)$$

with M_u the universe mass and $s_M (= 1/(\Sigma\alpha_n/M_n)$ the distance between the only mass M_u and the considered point. Moreover, the relation

$$u = \sqrt{-2U} = \sqrt{2MG/s} \Longrightarrow u^2 = 2MG/s \quad (4)$$

represents the known *escape speed*, and since $\boldsymbol{u}$ is a scalar, we have

$$u_{1,2} \equiv \sqrt{-2U_{1,2}} = \sqrt{-2(U_1 + U_2)} = [\left(\frac{2M_1G}{s_1}\right) + \left(\frac{2M_2G}{s_2}\right)]^{1/2} \quad (5)$$

which can be written as

$$u_{1,2}^2 = [\left(\frac{2M_1G}{s_1}\right) + \left(\frac{2M_2G}{s_2}\right)] = u_1^2 + u_2^2 \implies u_{1,2} = \sqrt{u_1^2 + u_2^2}. \quad (6)$$

For instance, the escape speed from Earth due to both Earth and Sun, becomes $u_{E,S} = \sqrt{u_E^2 + u_S^2}$ where $u_E = \sqrt{2M_E G/r_E}$ and $u_S = \sqrt{2M_S G/d}$, with M_E the Earth mass, r_E its radius, M_S the Sun mass, and d the distance Sun-Earth. Then, the escape speed from all the masses in space becomes

$$u = \sqrt{\sum u_n^2} = \sqrt{-2U} = \sqrt{\sum 2M_n G/s_n} = \sqrt{2M_u G/s_M}. \quad (7)$$

According to the NASA [1], WMAP spacecraft observations, the universe is *flat*, that is infinite in extent, having a mass density equal to the critical density $\rho_c = 9.9 \times 10^{-27}$ kg/m^3, while as for the total mass of the universe, many authors [2], [3] give $M_u \approx 10^{53}$ kg. Now, the finite mass of M_u implies $U_\infty = 0$, so we may assume its density as decreasing toward the infinity like a function $\rho = \rho_c e^{-as}$, hence

$$M_u = \int_0^\infty 4\pi s^2 \rho_c e^{-as} ds = \frac{8\pi\rho_c}{a^3} \approx 10^{53} \text{ kg} \implies a \approx (8\pi\rho_c/M_u)^{\frac{1}{3}} \approx 1.3 \times 10^{-26} \text{m}^{-1} \quad (8)$$

where $(2/a) \approx 1.5 \times 10^{26}$m, as hereafter shown, is the distance (s_M), between one mass M_u and the Earth, giving the same potential as all the masses. Indeed, on Earth, the variation of potential due to an increase of the distance ds can be written as $dU = -dmG/s$ with $dm = \rho 4\pi s^2 ds$ and $\rho = \rho_c e^{-as}$, therefore the potential U_0 on Earth becomes

$$U_0 = -\int_0^\infty (4\pi s^2/s) G \rho_c e^{-as} ds = -4\pi\rho_c G/a^2 \approx -4.5 \times 10^{16} \text{J} \Longrightarrow u_0 = \sqrt{-2U_0} \cong 3 \times 10^8 \text{ m/s} \quad (9)$$

As $\frac{U_0}{M_u} = -Ga/2$, comparing to Eq.(3) one gets $s_M = 2/a$. Now, assuming $c = u$, from Eq. (9), we find

$$c = \sqrt{-2U} \Longrightarrow U_0 = -c_0^2/2 \qquad \text{(on Earth)} \quad (10)$$

where U_0 is practically constant: indeed, its maximum variation in a year, due to the variable distance Earth-Sun, between Aphelion ($a = 1.52 \times 10^{11}$ m) and Perihelion ($p = 1.47 \times 10^{11}$ m), is

$$\Delta c_{AP} = -\frac{\Delta U_{AP}}{c_0} = -\frac{U_P - U_A}{c_0} = [\left(\frac{M_S G}{p}\right) - \left(\frac{M_S G}{a}\right)]/c_0 \cong 0.10 \text{ m/s}. \quad (11)$$

Let us give now the meaning of the escape velocity $\mathbf{u}$ from two or more masses: considering, first, one only mass *M*, let *m* be a massive point particle emitted, by a source *S*, with initial speed $u_S = (-2U_S)^{1/2}$ referred to *S*. During its *emission time T* which, because of the massiveness of *m*, has a finite value, the velocity of *m* referred to *S* is

$$\mathbf{v}_{Sm} \equiv \mathbf{u}_S \qquad [\text{with } |\mathbf{u}_S| = u_S = (-2U_S)^{1/2}] \tag{12}$$

we call it as *relative* escape velocity $\mathbf{u}_S$, where *relative* means here referred to *S* during *T*.

The velocity of *m* with respect to *M*, at the time of emission, becomes

$$\mathbf{v}_{Mm} = \mathbf{v}_{MS} + \mathbf{v}_{Sm} = \mathbf{v}_{MS} + \mathbf{u}_S \equiv \mathbf{u} \ \text{ with } |\ \mathbf{u}\ | = u = \sqrt{-2U} = \sqrt{2MG/s} \tag{13}$$

with *s* the distance *M-S* and where $\mathbf{u} = \mathbf{v}_{Mm}$ may be called as *effective* escape velocity where *effective* means here referred to *M*, that is the necessary velocity required by *m* to reach the infinity from the location of *S*; for instance, considering the Earth only, $\mathbf{u}_S$ represents the *relative* escape velocity of a particle *m* referred to its source *S*, $\mathbf{v}_{MS}$ is the velocity of *S* with respect to the Earth barycenter, while $\mathbf{u} = \mathbf{u}_S + \mathbf{v}_{MS}$ is the *effective* escape velocity of *m* .

Regarding now two masses, the related escape velocity $\mathbf{u}_{1,2}$ must comply with the Eq. (6), hence, being i_1 and i_2 two unitary vectors where $i_1 \perp i_2$, we have to write

$$\mathbf{u}_{1,2} = \mathbf{i}_1 u_1 + \mathbf{i}_2 u_2 \implies u_{1,2} = \sqrt{u_1^2 + u_2^2} \tag{14}$$

where $u_{1,2}$ also corresponds to the escape speed from the mass $M_{1,2}$(= M_1 + M_2) located in the center $B_{1,2}$ of the two masses, so $\mathbf{u}_{1,2}$ becomes the *effective* escape velocity to be referred to $B_{1,2}$.

Thus, for all the masses, with *B* their center, the Eq. (13) becomes

$$\mathbf{v}_{Bm} = \mathbf{v}_{BS} + \mathbf{v}_{Sm} = \mathbf{v}_{BS} + \mathbf{u}_S \equiv \mathbf{u}, \text{ with } |\ \mathbf{u}\ | = \sqrt{-2U} = \sqrt{2M_{\mathrm{u}}G/s_M} \tag{15}$$

showing that the *total* escape velocity $\mathbf{u}$ of a particle *m* (emitted by a source *S*) corresponds to the escape velocity from the total mass M_{u} at the distance s_M from *S*. The Eq. (15) also shows that only the particles emitted under the condition $|\mathbf{v}_{BS} + \mathbf{u}_S| \geqq |\mathbf{u}|$ will tend to the infinity; this apparent discrepancy will be explained on §1.6 regarding the emission of neutrinos. Besides, the equality *c* = *u* implies the light to have mass, hence a structure.

1.2 Structure of the Light

Let γ be a massive particle having, see Fig. 1, longitudinal/sinusoidal *elastic* shape, with *A* its *front, Z* its *tail*, emitted, during a given *emission time T*, by a source *S* at a speed $u_S \equiv c_S = \sqrt{-2U_S}$ referred to *S*.

Therefore, see Fig. 1-(**a**) where *S* is coincident with the observer *R*, the path λ covered by *A* during *T*

$$\lambda = v_{SA}T = u_S T = c_S T \tag{16}$$

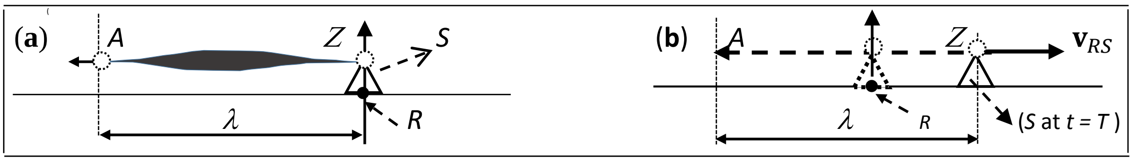


Figure. 1 –Emission of a λ-*particle*; (**a**) source *S* at rest with respect to the observer *R*; (**b**) source in motion from *R*.

corresponds to the particle length. Once emitted, given the emission time *T* and since u_S only depends on U_S, under a constant potential λ becomes invariant along a free path; the photon speed, as λ can be variable, has to be defined as $c = \lambda/T_t$ where T_t is the time (*transit time*) the *whole* particle needs to cross the considered observer.

Now, we may identify such particles as "photons", emitted by a source along rays (continuous succession of photons) where every photon tail is connected (as explained on chapter 2.1) to the front of the next one. Therefore the frequency of the light, at the time of its emission, referred to its source *S*, with t_0 the time unit, has to be defined as

$$\nu = n/t_0 = 1/T \implies \nu_R = 1/T_R \text{(as for an observer } R\text{)} \tag{17}$$

with n the number of photons flowing along *one* ray during the time unit, *T* the emission time of one photon, T_R the transit time referred to *R*.

Moreover, the photons frequency emitted by a source *S* and stated by an observer *R*, is invariant if $\mathbf{v}_{RS} = 0$, nevertheless *R* and *S* are at different potential; for instance, the number of particles emitted downwards from the top of a tower in a time *t*, is equal to their number received, during an equal time, on the tower base, thus

$$\nu_S = \nu_R \quad \text{[valid for } \mathbf{v}_{RS} = 0\text{, even if } U_S \neq U_R\text{].} \tag{18}$$

Now, referring to Fig. 1(**b**), with $|\mathbf{v}_{RS}| \equiv v$, according to the Galileo's velocities composition law, we should have

$$c_R = c_S - v = c_S(1-\beta)\,,\ \text{with } \beta = v/c_S \tag{19}$$

appearing contrary to every experiment, but this discrepancy is solved on chapter 1.4 # 1. Then, see Fig. 1(**b**), being vT/c_R the time the tail *Z* needs to cover the path $S_T \to R$, the transit time related to *R* is $T_R = T + vT/c_R$ yielding

$$T_R = T[1 + v/c_S\,(1-\beta)] = T[1 + \beta/(1-\beta)] = T/(1-\beta)] \implies \nu_R = \frac{1}{T_R} = \nu(1-\beta) \tag{20}$$

where ν_R is the frequency observed by *R*, and therefore

$$\lambda_R = c_R T_R = c_S(1-\beta)\,T/(1-\beta) = \lambda \tag{21}$$

invariant to Doppler effect (DE). Note that the Eqs. (19)→(21) are valid for a free path of the light; they do not take into account the interaction light-matter, which may change, see § 1.4, the parameters of the re-emitted photons.

1.3. Physical Characteristics of the Photon

Because of the light massiveness, its kinetic energy of, like a fluid flowing along a pipe, has to be $K_c = \frac{1}{2}mc^2$ and therefore equating K_c to the empirical relation $E = h\nu$, we have

$$E = \frac{1}{2}mc^2 = h\nu \tag{22}$$

which represents the energy of the photons flowing along *one* ray, and where

$$m = 2h\nu/c^2 \equiv \gamma\nu \implies E = \frac{1}{2}\gamma\nu c^2 \tag{23}$$

with m the mass of photons passing along one ray in 1s, while the constant

$$\gamma = 2h/c^2 = m/\nu = mT = 1.474499 \times 10^{-50} \text{ kg s} \tag{24}$$

is the mass of *one* photon. Then, from Eq. (24), the Planck's constant

$$h = \frac{1}{2}\gamma c^2 \tag{25}$$

turns out to be the kinetic energy of one photon; h is not a real constant as it depends on *c.*

The Eq.(22) regards *one ray*; thus being n_r the number of rays emitted by a source *S*, the term

$$E_{tot} = n_r \frac{1}{2}mc^2 \tag{26}$$

is the total energy emitted by *S*. During the time unit t_0, E_{tot} equals the power *P* supplied by *S*, thus

$$E_{tot}/t_0 = n_r \frac{1}{2}mc^2/t_0 = P \tag{27}$$

therefore, avoiding t_0, the Eq. (27) can be written as

$$n_r m \equiv m_{\text{tot}} = 2P/c^2 \tag{28}$$

which is the total mass lost per second by a source of light; e.g. for a 1W lamp we get

$$m_{\text{tot}} = 2P/c^2 \cong 2.2 \times 10^{-17} \text{ kg s}^{-1} \tag{29}$$

while the number n_r of rays is

$$n_r = m_{\text{tot}}/m = m_{\text{tot}}/\gamma\nu = 2P/c^2\gamma\nu = P/h\nu \tag{30}$$

which, as for a sodium-vapour lamp of 1 W, having λ = 589 nm, gives $n_r \cong 3\times10^{18}$ rays, and we point out that, as for a given power *P*, the higher is the frequency, the lower is the number of rays, as shown by Eq.(30) written as $n_r\,\nu = P/h$. Then, the number of photons n_γ emitted in 1s by a source, becomes

$$n_\gamma = (n_r\,\nu) = P/h;\ \text{for } P = 1\text{W} \implies n_\gamma = h^{-1}\ (\cong 1.5\times10^{33}\ \text{photons/s}) \tag{31}$$

so, the *inverse* **of Planck's** constant turns out to be the number of photons emitted in 1s by a source of unitary power. Finally, the momentum of a ray of photons, like any mass having K_c= ½ mc^2, is therefore

$$\mathbf{p} = m\mathbf{c} = \gamma\nu\mathbf{c} = \gamma\mathbf{c}/T. \tag{32}$$

1.4. Invariance of *c* during its measurement

Let *S* be a source of light emitting photons impacting a structure R (also representing a measurement system of *c*) which re-emits (with different parameters), see Fig. 2, the incident photons having parameters ν_0, λ_0.

Let be, first, $\mathbf{v}_{RS} = 0$. When a ray of light reaches *R*, (for simplicity on frontal impact), the incident photons are absorbed by a circling electron which, due to the impact, see Fig. 5 on § 2.1, takes on a radial velocity **w** whose final value, see Eq. (32) $m_0 c_0 = m_e w_0$, is $w_0 = \gamma \nu_0 c_0 / m_e$. So, during the interaction time t_i, (from t_{in} to t_{out}) see Fig. 2-**b**, the photons frequency referred to the moving electron, because of its speed w_i variable from 0 to w_0, see Eq. (20), becomes

$$\nu_i = \nu_0(1-\beta_e) \qquad \text{with } \beta_e = w_i/c_0 \;\; (= m_0/m_e \text{ for } w_i \to w_0\,) \,. \tag{33}$$

So, considering first the experimental equality $c_{R\,out} = c_0$, at $t = t_{out}$ we get

$$\lambda_{R\,out} = c_{R\,out}/\nu_{R\,out} = c_0/\nu_0(1-\beta_e) = \lambda_0/(1-\beta_e) \qquad \text{(increase of } \lambda_0\text{)}. \tag{34}$$

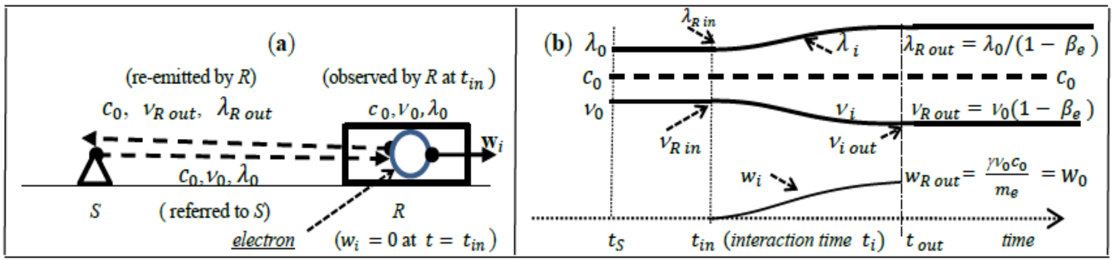


Figure. 2. Photons emitted by a source *S* at rest with respect to the observer *R* which re-emits the received photons. (**a**) Photons emission and re-emission; (**b**) Scheme of the photons parameters during the *interaction time* t_i .

Anyhow, the equality $c_{R\,out} = c_0$ is also explained through the conservation of energy which, during the interaction light-matter, can be written as $E_0 - E_{R\,out} = \Delta E_{el}$ where $E_0 = \frac{1}{2}\gamma c_0^2\,\nu_0$, see Eq. (23), is the photons energy emitted by *S*, $E_{R\,out} = \frac{1}{2}\gamma c_{R\,out}^2\,\nu_0(1-\beta_e)$ the re-emitted one, and where $\Delta E_{el} = \frac{1}{2} m_e\,(v_0^2 - v_1^2)$ is the variation of the kinetic energy of the circling electron between its ground-state orbit r_0 and a wider orbit r_1. In fact, the photons energy to move a circling electron from r_0 to $r_{\to\infty}$ equals the work function W_f = ½ $m_e v_0^2$ = $h\nu_0$ as also shown by Eq. (102), so between r_0 and r_1 we can write, see also Eq. (67), $\frac{1}{2} m_e (v_0^2 - v_1^2) = h\nu_0 - h\nu_1$ in our case $h\nu_0 - h\nu_0(1-\beta_e)$ yielding $\frac{1}{2}\gamma c_0^2\,\nu_0 - \frac{1}{2}\gamma c_{R\,out}^2\,\nu_0(1-\beta_e)$; so the previous $E_0 - E_{R\,out} = \Delta E_{el}$ equals

$$\tfrac{1}{2}\gamma c_0^2\,\nu_0 - \tfrac{1}{2}\gamma c_{R\,out}^2\,\nu_0(1-\beta) = \tfrac{1}{2}\gamma c_0^2\,\nu_0 - \tfrac{1}{2}\gamma c_0^2\,\nu_0(1-\beta) \implies c_{R\,out} = c_0. \tag{35}$$

Let now be $\mathbf{v}_{RS} \neq 0$. So, see Fig. 2A-(**d**), the photons speed when impacting the electron at t_{in}, because of $\mathbf{v}_{RS}$, is $c_{R\,in} = c_0 - v = c_0(1-\beta_S)$, where $\beta_S = v/c_0$, while being λ invariant to DE, $\lambda_{R\,in} = \lambda_0$.

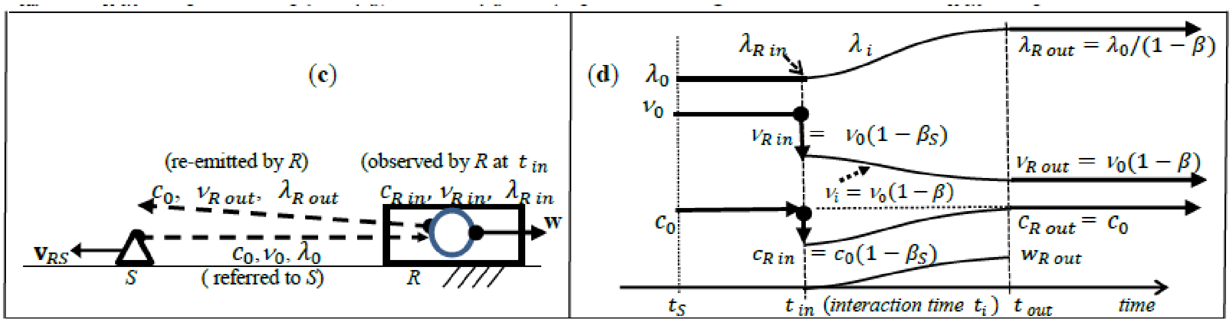


Figure. 2.A - Photons emitted by *S* in relative motion from *R* which re-emits the received photons. (**c**) Emission and re-emission of the photons; (**d**) Scheme of the photons parameters during the *interaction time* t_i .

Therefore, at t_{in}, the frequency becomes $\nu_{R\,in} = c_{R\,in}/\lambda_{R\,in} = \frac{c_0(1-\beta_S)}{\lambda_0} = \nu_0(1-\beta_S)$; but, during t_i, since the electron, with respect to *S*, has now speed $(w+v)$, we have $\nu_i = \nu_0(1-\beta)$ where $\beta = \beta_e + \beta_S$, (in general $\beta = \beta_e \pm \beta_S$), and because of the stated relation $c_{R\,out} = c_0$ we get $\lambda_{R\,out} = c_0/\nu_0(1-\beta) = \lambda_0/(1-\beta)$, hence $\lambda_{R\,out}\,\nu_{R\,out} = c_0$.

Note that the Fig. 2, where $\mathbf{v}_{RS} = 0$, represents the Compton effect, frontal impact, which, on our results, see Eq. (119), gives $\lambda' = \lambda_0/(1-\beta)$, with $\beta = w/c_0$ where *w* is the recoiled electron speed; on the contrary, the *Compton equation* frontal impact gives, see also Eq.(120), $\lambda' = \lambda_0(1+\beta)$, hence c'= $\lambda'\,\nu'$ = $\lambda_0(1+\beta)\,\nu_0(1-\beta) \cong c_0$, instead of the exact c_0.

1.5 Speed of light under a variable potential

 # 1 - Photons at their emission in altitude, with $\mathbf{v}_{RS}$ = 0.

Referring to Fig. 3-(**a**), the variation of potential U_{0h} from ground to *h* (= $r_h - r_0$) << r_0 (Earth radius) is

$$U_{0h} = U_{(E)h} - U_{(E)0} = -(M_E G/r_h) + (M_E G/r_0) \cong M_E G h/r_0^2 = gh \qquad (36)$$

and since $U_0 = -\,c_0^2/2$ as per Eq. (10), and being $U_h = -\,c_h^2/2$, the total potential at height *h* yields

$$c_h = \sqrt{-2U_h} = \sqrt{-2(U_0 + U_{0h})} = \sqrt{c_0^2 - 2gh} \cong c_0(1 - gh/c_0^2) \equiv c_0(1-\varepsilon) \text{ [with } \varepsilon \equiv gh/c_0^2] \quad (37)$$

showing a decrease of *c* from ground to *h*.

Now, it is known that atomic clocks in altitude are increasing their ticking time T_h (their photons emission time) with respect to identical clocks on the ground, implying a decrease of their frequency from ν_0 to $\nu_h = 1/T_h$ .Thus we may infer that this decrease of ν has to be equal to the variation of *c* from ground to *h*, see Eq. (37), so we can write

$$\nu_h = \nu_0(1-\varepsilon) \Longrightarrow T_h = 1/\nu_h = T_0/(1-\varepsilon) \cong T_0(1+\varepsilon) \qquad (38$$

that is the photons emission time and their frequency in altitude. Then, see Fig. 3(**a**), we have

$$\lambda_h = c_h T_h = c_0(1-\varepsilon)T_0/(1-\varepsilon) = c_0 T_0 = \lambda_0 \tag{39}$$

showing that λ is invariant if the source S is emitting at different potential. Note that *the* Relativity Theory (**RT**)*, as for the Eqs. (37)→(39), predicts, see Fig. 4-(**a**), these values:* $c_h = c_0$; $\lambda_h = \lambda_0$; $\nu_h = \nu_0$.

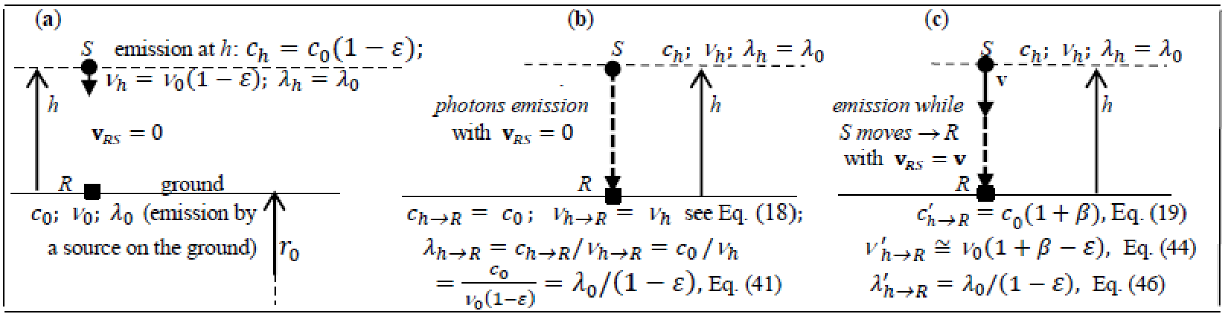
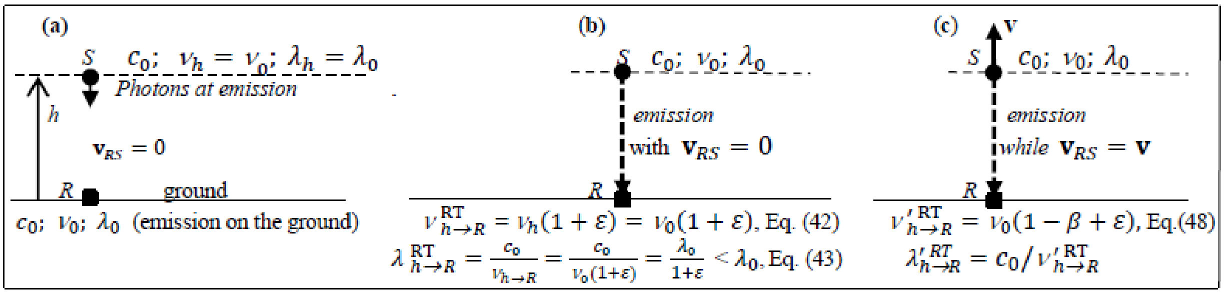


Figure 3. Parameters of photons, ***our results***. (**a**): emission in altitude; (**b**): photons reaching the detector *R* which goes out of resonance; (**c**): direction of the *compensation velocity* **v**, to restore the resonance *S-R*.

Figure 4 – Same as Fig. 3, but ***results according to*** **RT**.



#2. **Photons emitted in altitude and reaching the ground, with $\mathbf{v}_{RS}$** = 0.

Referring to Fig. 3-(**b**), with $\mathbf{v}_{RS} = 0$, the speed of photons reaching R from h is $c_{h\to R} = c_R = \sqrt{-2U_0} = c_0$ and since the condition $\mathbf{v}_{RS} = 0$ implies, see Eq.(18), $\nu_{h\to R} = \nu_h$, and since, see Eq.(38), $T_h = T_0/(1-\varepsilon)$, we get

$$T_{h\to R} = 1/\nu_{h\to R} = \frac{1}{\nu_h} = \frac{1}{\nu_0(1-\varepsilon)} = \frac{T_0}{(1-\varepsilon)} = T_h \implies \nu_{h\to R} = \nu_h = \nu_0(1-\varepsilon) \tag{40}$$

meaning that the time counted by an atomic clock (AC) in altitude (T_h), and then transmitted to the ground ($T_{h\to R}$) under the condition $\mathbf{v}_{RS} = 0$, is invariant ($T_{h\to R} = T_h$), hence different from the time (T_0) counted on Earth by an equal AC. Thus

$$\lambda_{h\to R} = c_R T_{h\to R} = c_0 T_0/(1-\varepsilon) = \lambda_0/(1-\varepsilon) \cong \lambda_0(1+\varepsilon) \tag{41}$$

showing that $\lambda_{h\to R}$, see Fig. 3-(**b**), has increased its value from λ_h $(=\lambda_0)$ in altitude, to: $\lambda_{h\to R} = \lambda_0(1+\varepsilon) > \lambda_0$ hence a **redshift**.

One could observe that, on our results, during the photons path *h-R*, the energy of light $E = h\nu$, with *h* the Planck's *constant*, and under the condition $\mathbf{v}_{RS} = 0$ which implies the constancy of ν, seems to be invariant, but this apparent discrepancy is due to the reason that the Planck's *constant* is not a real constant, as shown on Eq. (25); by the way, the non-constancy of *h* has already been arisen [4].

Now, the Harvard tower experiment (HTE) shows that a detector (*R*) on the ground, in resonance at frequency ν_0 with a source at the same level, goes out of resonance if the source is taken to an altitude *h*; in fact, in altitude, see (38), $\nu_h = \nu_0(1-\varepsilon)$, and therefore, under the condition $\mathbf{v}_{RS} = 0$, the frequency of the photons emitted at *h* and reaching *R*, see Eq. (40), remains constant, that is $\nu_{h\to R} = \nu_0(1-\varepsilon)$, hence *R* goes out of resonance when the photons reach the ground.

On the contrary, see Fig.4-(**b**), *according to* **RT**, *the frequency of the photons emitted at h and moving downwards,* $\nu_{h\to R}^{\mathrm{RT}}$, *is increasing* [5], [6], *from its claimed value* $\nu_h (= \nu_0)$ *in altitude, according to the following relation*

$$\nu_{h\to R}^{\mathrm{RT}} = \nu_0(1+\varepsilon) \text{ (predicted by RT)} \tag{42}$$

so, to restore the resonance via DE, the source, contrary to our results, should move up, see Fig. 4-(**c**). *Moreover, still according to* **RT**, *we have*

$$\lambda_{h\to R}^{\mathrm{RT}} = c_0/\nu_{h\to R}^{\mathrm{RT}} = c_0/\nu_0(1+\varepsilon) = \lambda_0/(1+\varepsilon) \cong \lambda_0(1-\varepsilon), \textit{ blueshift} \text{ [predicted by RT]} \tag{43}$$

contrary to our Eq. (41), and also contrary to the redshift of far sources, where $|U| \ll |U_0|$.

3. ***Photons reaching the ground, meanwhile S moves with speed*** $v = |\mathbf{v}_{RS}|$ ***from h to R***, see Fig. 3(c).

The speed of photons, emitted in altitude by a source moving toward *R*, when reaching the ground, see Eq.(19), is $c'_{h\to R} = c_0(1+\beta)$; at the same time, their frequency, from *h* to *R,* see Eq. (20), becomes

$$\nu'_{h\to R} = \nu_h(1+\beta) = \nu_0(1-\varepsilon)(1+\beta) \cong \nu_0(1+\beta-\varepsilon) \tag{44}$$

hence

$$T'_{h\to R} = 1/\nu'_{h\to R} = 1/\nu_0(1-\varepsilon)(1+\beta) = T_0/(1-\varepsilon)(1+\beta). \tag{45}$$

Then, since $\lambda'_{h\to R} = c'_{h\to R}T'_{h\to R} = c_0(1+\beta)T'_{h\to R}$ we get

$$\lambda'_{h\to R} = \frac{c_0(1+\beta_*)T_0}{(1-\varepsilon)(1+\beta)} = \frac{\lambda_0}{1-\varepsilon} \cong \lambda_0(1+\varepsilon) \quad \text{(redshift)} \tag{46}$$

showing that $\lambda'_{h\to R}$ is not influenced by the relative motion source-observer stated by β. Now, to restore the resonance, *S* has to move toward *R* so to increase the frequency from $\nu_{h-R} = \nu_0(1-\varepsilon)$ to $\nu'_{h\to R} = \nu_0(1-\varepsilon)(1+\beta)$: indeed, for $\beta \cong \varepsilon$ <<1, see also Fig. 3-(**c**), we get $\nu'_{h\to R} \cong \nu_0$, the resonance frequency. Then, according to Eq. (44), for $\beta = \varepsilon$ we get $\nu'_{h\to R} \cong \nu_0$ and therefore the relation

$$v = \varepsilon c_0 = gh/c_0 \tag{47}$$

is the condition to restore the resonance. Indeed, the direction of **v** (**moving down**) to restore the resonance *S-R*, was not detected on HTE, as its purpose [5]-[8] was to measure the variation of the frequency under the Earth's gravity.

Regarding the **RT***, the frequency, from h to R, see Eq.(42), is* $\nu_{h\to R}^{\mathrm{RT}} = \nu_0(1+\varepsilon)$ *hence to restore the resonance, in order to reduce the frequency, S should* ***move up****, according to the relation*

$$\nu'^{\,\mathrm{RT}}_{h\to R} = \nu_{h\to R}^{\mathrm{RT}}(1-\beta) = \nu_0(1+\varepsilon)(1-\beta) \cong \nu_0(1-\beta+\varepsilon) \tag{48}$$

opposite to our Eq. (44).

1.6 Harvard Tower Experiment in accordance with our results

For a beam emitted in altitude and reaching R (ground), the **RT** *predicts, see Eq. (42), the relation*

$$\nu_{h\to R}^{\mathrm{RT}} = \nu_0(1+\varepsilon) = \nu_0\left(1+\frac{gh}{c^2}\right) \tag{49}$$

and since E = hν*, on the basis of the constancy of the Planck's constant, and because of the* **RT** *assumption* $\nu_h = \nu_0$*, from h to the ground, the* **RT** *claims*

$$\Delta E/E = \Delta\nu/\nu = (\nu_{h\to R}^{RT} - \nu_h)/\nu_h = [\nu_0(1+\varepsilon) - \nu_0]/\nu_0 = \varepsilon = gh/c^2 \tag{50}$$

which has been verified, as a variation of the frequency, by the HTE for a beam moving from h to R (and vice versa), giving, for h = 22.5 m, *the value* $2\Delta E/E$ = $2\Delta\nu/\nu$ = 4.9×10^{-15}.

On our results, since $m_0 = \gamma\,\nu_0$ as per Eq. (23), the energy of the light on the ground is

$$E_0 = ½\, m_0 c_0^2 = ½\,\gamma\,\nu_0 c_0^2 \tag{51}$$

while at the altitude *h* we have

$$E_h = ½\, m_h c_h^2 = ½\,\gamma\,\nu_h c_h^2 = ½\,\gamma\,\nu_0(1-\varepsilon)c_0^2(1-\varepsilon)^2 = ½\, m_0 c_0^2(1-\varepsilon)^3 = E_0\,(1-\varepsilon)^3 \tag{52}$$

and therefore, as $\varepsilon \ll 1$ one gets

$$E_0/E_h = 1/(1-\varepsilon)^3 \Longrightarrow (E_0 - E_h)/E_h \cong 3\varepsilon \cong 3gh/c_0^2 \tag{53}$$

different from Eq. (50) obtained with *h constant*. In fact, being $\nu_h = \nu_0(1-\varepsilon)$, from R to h it is $(\nu_0 - \nu_h)/\nu_h = [(\nu_0 - \nu_0(1-\varepsilon)]/\nu_0(1-\varepsilon) \cong \varepsilon$ and the same from h to R, so we get $2\Delta\nu/\nu \cong 2\varepsilon$ according to the HTE result.

1.7 Emission of neutrinos and their cosmological meaning

We have to clarify two anomalies regarding (i) the *nuclear* emission of light and (ii) its *effective* escape velocity $\mathbf{u}$.

During the nuclear reaction n + p $\rightarrow$ d + γ where γ is a detected photon, there is a loss of a mass *m* (which is measured) in accordance with the relation $E = mc^2$ regarded as an equivalence mass-energy; but, under the assumption of the massiveness of light, the total mass before/after the reaction has to remain constant: at this regard, (1st anomaly), since the kinetic energy of massive photons, see Eq. (22), is K_c = ½ mc^2 and because of the absolute validity of $E = mc^2$, we only have to infer that, during the nuclear reactions where photons are emitted, other particles, difficult to be detected, having same mass and same speed as the light, *but velocity with contrary direction*, should be emitted together with the photons; this *elusive* massive particles, we know having speed equal to *c*, are the neutrinos. On this basis, as for nuclear emission of light, we should write

$$E = mc^2 = \tfrac{1}{2} mc^2 + \tfrac{1}{2} mc^2 = K_c + K_\nu \qquad (54)$$

where K_c regards the kinetic energy of the light, $K_\nu = \tfrac{1}{2} mc^2$ the neutrinos.

Moreover, (2nd anomaly), we have seen that the speed of light, emitted by a source *S* at *relative* escape velocity $\mathbf{u}_S$, because of the velocity $\mathbf{v}_{BS}$ of *S* with respect to the center *B* of all the masses, due to the relation $\mathbf{u} = \mathbf{u}_S + \mathbf{v}_{BS}$, could not be equal, see Eq. (15), to the *effective* escape velocity $\mathbf{u}$; indeed, during these reactions, due to the emission of a neutrino having velocity contrary to each emitted photon, one of the two particles will surely tend to the infinity.

On these bases, at their simultaneous emission, one of the two particles will have the necessary velocity to reach the infinity, in accordance with their cosmological reason (described on the Introduction). Moreover, the emission of neutrinos explains, in another way, the Eq. (54).

One could object why photons and neutrinos, have same mass and speed, but different behavior: in fact, the light interacts with the matter, whereas neutrinos can be detected only through particular measures; at this regard, the photons, in order to interact with the circling electrons, must have (like an electric dipole) a positive charge on their front and an equal negative one on their tail, whereas the *sterile* neutrinos, in our opinion, have no charges, and therefore they cross the matter with a neglecting interaction. The co-existence of these two particles is to avoid, in our opinion, the gravitational collapse of the universe.

1.8 Gravitational redshift

According to **RT***, the only way to explain high cosmological redshifts, is the Doppler effect, which implies an endless expansion of the universe; moreover, the high redshifts of the light coming from far sources, because of the claimed constancy of c, imply a decrease of the frequency of the light during their path sources-Earth, hence a reduction of the energy of the light, which has not been clearly explained by* **RT**.

On the contrary, the frequency ν emitted by a source where $|U| < |U_0|$, with U_0 the potential on Earth, is lower than ν_0 as shown by Eq. (38), and therefore under the condition $\mathbf{v}_{ES} \cong 0$, it turns out that, according to Eq. (18),the frequency emitted by this source will reach the Earth practically with its initial value. Thus, neglecting any relative motion between a far source and an observer on Earth, we have $\nu = \nu_0$ that is $c/\lambda = c_0/\lambda_0$, (where c_0, λ_0 are referred to the Earth), hence the gravitational red shift $z = \Delta\lambda/\lambda$ can be expressed by the relation

$$z = \frac{\Delta\lambda}{\lambda} = \frac{\Delta c}{c} = (c_0 - c)/c = (c_0/c) - 1 = \sqrt{U_0/U} - 1 \tag{55}$$

with U_0 the total potential on Earth, U the one on the source, and we point out that this relation, for $U \to 0$ (towards the infinity), yields on Earth high redshifts, as observed.

So, neglecting any Doppler effects, *z* turns out to be the effect of the variation of potential during the path of light; in particular, according to the NASA database [9], with *s* the distance source-Earth, for *s* < ≅ 45 Mpc, ≅ 150 Mly, we observe blue/redshifts in the range – 0.01 < *z* < + 0.01, meaning that close to our region, the potential *U*, in *absolute value*, may be higher or lower than the potential on Earth U_0; in the range ≅ 0.01 < *z* < ≅ 0.20, (where *z* follows the empirical Hubble's law), the (55), written as

$$U = U_0/(1+z)^2 \cong U_0/(1+2z) \cong U_0(1-2z) \quad \text{(valid for z << 1)} \tag{56}$$

shows that, for *z* << 1, *U* depends linearly on *z* like the empirical Hubble's law, while for *s* >≅ 45 Mpc, and therefore $|U_0| > |U|$, *z* is always positive. Hence we may argue that our galaxy is close to the center of the masses of universe, otherwise the observed *z* should be mostly negative.

1.9 Time dilation

As for the **RT**, [10], [11], *the time dilation* t_d *referred to* t_{1s} =1 s, *between an altitude h and the ground, is*

$$t_{d\ 1s} \equiv (t_h - t_{1s})/t_{1s} = \sqrt{1 - 2M_E G/rc^2} \cong 1 - M_E G/rc^2 \tag{57}$$

where $M_E G/c^2$ *is the Schwarzschild radius of the Earth, and r is the distance between the Earth's center and the considered points,* r_0 *and* r_h*; therefore, from* r_0 *to* r_h, (*where* $r_h = r_0 + h$), *and avoiding, on this following relation, the time unit, the* **RT** *gives*

$$t_{d\ 1s} \equiv \frac{t_h - t_{1s}}{t_{1s}} = [\left(\frac{M_E G}{r_0}\right) - \left(\frac{M_E G}{r_h}\right)]/c^2 = (U_h - U_0)/c^2 = gh/c^2. \tag{58}$$

On our results, in altitude, see Eq. (38), the emission time of any source of light, like an atomic clock (AC) is $T_h = T_0/(1-\varepsilon)$, so we can write

$$\frac{T_h}{T_0} = \frac{1}{1-\varepsilon} \Longrightarrow \quad (T_h - T_0)/T_0 = \frac{\varepsilon}{1-\varepsilon} \tag{59}$$

yielding

$$t_{d\ 1s} += \frac{\left[\frac{T_0}{(1-\varepsilon)} - T_0\right]}{T_0} = \frac{1}{1-\varepsilon} - 1 = \frac{\varepsilon}{1-\varepsilon} \cong \varepsilon \cong \frac{gh}{c_0^2} \tag{60}$$

showing that, on our results, the *time dilation* in altitude corresponds to the relative variation of the photons emission time of the AC's at different potential.

Part 2 - Interaction light-matter

2.1. Electron Structure and Photon-Electron *Impact Point*

In order to move a circling electron toward outer orbits, the impacts photons-electron must give origin, see Figure 5-**(a)**, to an electron *radial velocity* **w**, therefore the impacts have to occur in a specific point of the electron surface, we name it *Impact Point* (I_p) which, *during the electron revolution*, has to face the atom nucleus up to the electron removal from its atom.

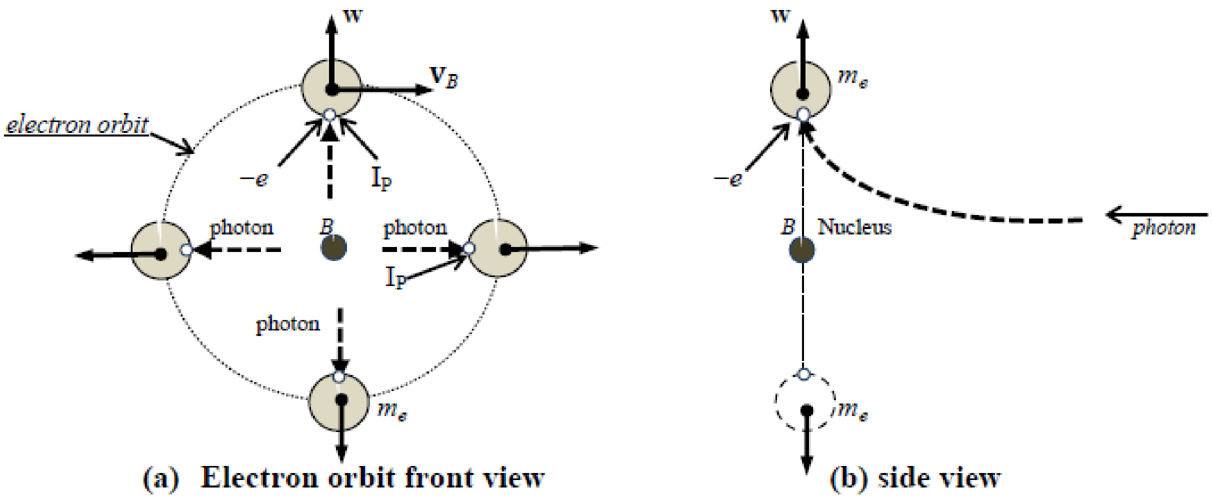


Figure 5**. Impact photons-electron**. The impact point (I_p) corresponds to the electron charge, while **w** ***is electron radial velocity due to the impact;*** *its direction is the same as the photons during the impact., hence the photons frequency, referred to the impacting electron, has to decrease according to the DE.*

Besides, the impacts photons-electron, in order to give origin to an electron radial velocity **w**, must have, see Figure 5-(**b**), at the time of impact, the direction B-I_p (nucleus-impact point) and this can be effected if each photon *front* has to be provided with a positive charge while its *tail* with an equal negative one, like an electrical dipole.

2.2.H Atom Parameters and Meaning of Quantum Numbers

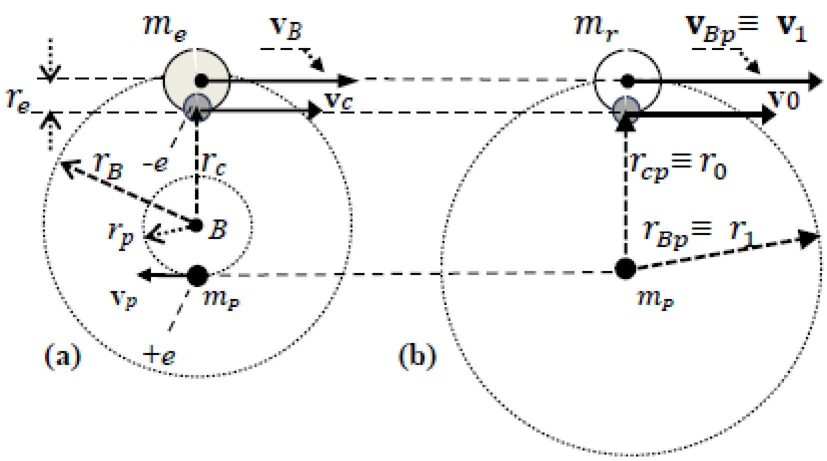


Figure 6. H atom equivalent configurations, on our bases. **(a)** Atom observed from the electron-proton common center of gravity *B*; **(b)** Observed from the proton, orbited by the electron with reduced mass m_r.

The Fig 6-(**a**) represent, on our bases, the ^{1}H atom *basic* configuration, where the electron and its charge, having different orbits, are circling around the electron-proton common center of gravity *B*, while on the conf. (**b**) the atom is observed from the proton, fixed as origin with the electron having the reduced mass

$$m_r = m_e/(1 + m_e/m_P) = m_e/(1 + \varepsilon_m) = 9.104422 \times 10^{-31}\,\text{kg}, \quad \text{with } \varepsilon_m = m_e/m_P \quad (61)$$

Hereafter, we give the H atom parameters referred to the conf. (**a**) and (**b**).

	Conf. (**a**)	Conf. (**b**)
electron mass	m_e	m_e
electron radius	r_e	r_e
proton orbit	r_p	0
proton orbital speed	$v_p = \lvert\mathbf{v}_P\rvert$	0
orbit of electron charge	r_c	$r_{cp} = r_c + r_p \equiv r_0$
orbital speed of el-charge	$v_c = \lvert\mathbf{v}_c\rvert$	$v_{cp} = v_c + v_p \equiv v_0$
orbit of el-center	r_B	$r_{Bp} = r_B + r_p \equiv r_1$
orbital speed of el-center	$v_B = \lvert\mathbf{v}_B\rvert$	$v_{Bp} = v_B + v_p \equiv v_1$

Table # 1. H atom parameters related to the ground state (g-s) configurations of Fig. 6.

On H atom, for each electron circular orbit r_n, the emitted frequencies of spectrum satisfy the relation

$$\nu_n = \frac{\nu_0}{n^2} \quad (n = 1,2,3, \dots). \qquad (62)$$

Then, since the frequency is the number of photons flowing along one ray during the time unit, it turns out that $n^2 = \nu_0/\nu_n$ represents the ratio between the number of photons absorbed (or emitted) by the electron along its ground-state orbit r_1 during $T_0(= 1/\nu_0)$, and their number along its orbit r_n during T_n (= $1/\nu_n$). In details, along $r_1(n = 1)$, only 1 photon is admitted (or released during *emission*), while along r_n their number is n^2. The quantum numbers are therefore related to the ***integer*** number of the admitted (or released) photons, while the integer n corresponds to the progressive number of each circular orbit r_n.

Now, still referring to Fig. 6-(**b**), since $r_e \ll r_0$, *for the time being* we may write $r_1 \cong r_0$, $v_1 \cong v_0$ and therefore, we could apply, with sufficient accuracy, along the orbit r_0, the equality between the electron centrifugal force and the Coulomb force, giving

$$m_r v_0^2/r_0 \cong e^2/4\pi\varepsilon_0 r_0^2 \Longrightarrow m_r v_0^2 \cong e^2/4\pi\varepsilon_0 r_0 \qquad (63)$$

where $e^2/4\pi\varepsilon_0 r_0$ is the energy needed to move the electron charge from r_0 toward the infinity (on microscopic scale).

On the other hand, the ^{1}H ionization energy $W_0 \cong 13.5984$ eV corresponds to the energy necessary to move the *circling* electron, (having a kinetic energy $K_c = ½\, m_r v_1^2$), from its ground state (g-s) orbit r_1, towards the infinity and therefore we may write

$$W_0 \cong ½\, m_r v_0^2 \tag{64}$$

and then

$$W_0 \cong ½\, m_r v_0^2 \cong \frac{e^2}{8\pi\varepsilon_0 r_0} \cong 13.5984 \text{ eV} \Longrightarrow \; v_0 \cong (2W_0/m_r)^{1/2} \cong 2187700 \text{ m s}^{-1} \tag{65}$$

with v_0 the empirical value of the orbital speed of the electron charge. Therefore, if W_0 is supplied by one ray of light $E_0 = h\nu_0$, with ν_0 the necessary frequency to remove the electron, we have $W_0 = E_0 = h\nu_0$ yielding

$$W_0 \cong ½\, m_r v_0^2 \cong h\nu_0 \;\cong e^2/8\pi\varepsilon_0 r_0 \Longrightarrow r_0 \cong e^2/8\pi\varepsilon_0 W_0 \cong 5.29461 \times 10^{-11} \tag{66}$$

which is the empirical value of the electron charge orbit, see Fig. 6-(**b**). Besides, between two orbits we can write

$$\Delta W = ½\, m_r v_1^2 - ½\, m_r v_2^2 = h\nu_1 - h\nu_2 = \Delta E \tag{67}$$

with ΔE the photons energy to move a circling electron from r_1 to r_2. Then, from Eq. (66),

$$\nu_0 \cong \frac{e^2}{8\pi\varepsilon_0 r_0 h} \cong 3.288079 \times 10^{15}\text{s}^{-1} \tag{68}$$

consistent with the known value $\nu_0 = R_H c = 3.288051 \times 10^{15}\text{s}^{-1}$, the highest frequency of the H atom spectrum, also obtaining

$$r_0 = \frac{e^2}{4\pi\varepsilon_0\, m_r v_0^2} = \frac{e^2}{2W_0 4\pi\varepsilon_0}. \tag{69}$$

Now the empirical value of the ratio ν_0/f_0, where f_0 is the electron frequency along r_0, becomes

$$\nu_0/f_0 \cong \nu_0 2\pi r_0/v_0 \cong 0.499998 \tag{70}$$

practically corresponding to the absorption/emission of a *half* photon during *one* orbit of the electron and since **the number of photons has to be an integer**, we have to infer that the electron has to make two orbits in order to receive (or to emit during the emission) the photon ν_0, hence we have to impose

$$2\nu_0/f_0 = 1 \;\; \textit{\textbf{exact}} \tag{71}$$

meaning that, along r_0, the impacting/emission time T_0 $(= 1/\nu_0)$ lasts for two electron orbits**;** for simplicity, we call this *double* orbit as "d-orbit". Then, the (68) can also be written as

$$\nu_0 = e^2 c/2\varepsilon_0 hc\; 4\pi r_0 = \alpha c/4\pi r_0 \tag{72}$$

with $\alpha = e^2/2\varepsilon_0 hc$ the fine structure constant; thus, according to Eq. (71),we have

$$\delta_0 \equiv 2\nu_0/f_0 = \;(2\,\alpha c/4\pi r_0)/(v_0/2\pi r_0) = \alpha c/v_0 = 1 \tag{73}$$

and then

$$v_0 = \alpha c \tag{74}$$

representing, see Fig, 6-(**b**), the *exact* orbital speed of the electron charge along r_0. Then from (65) we also find

$$\nu_0 = m_r v_0^2/2h = m_r \alpha^2 c^2/2h = R_{\mathrm{H}} c \tag{75}$$

where $R_H = m_r \alpha^2 c/2h = \nu_0/c = 1/\lambda_0$ is the Rydberg constant.

Now the correct value of r_0, still from (69), becomes

$$r_0 = \frac{e^2}{8\pi\varepsilon_0 h\nu_0} = \frac{e^2}{8\pi\varepsilon_0 h R_{\mathrm{H}} c} = \frac{\alpha}{4\pi R_H} = 5.294654 \times 10^{-11}\ \mathrm{m} \tag{76}$$

representing, see Fig.6-(**b**), the g-s orbit of the electron charge as observed from the proton.

[Regarding the *Bohr radius,* referring to Fig. 6-(**a**), assuming m_e as coincident with its charge along the orbit r_c, we should write $m_e v_c = m_P v_P$; then, since $v_c/r_c = v_P/r_P$ we should get $m_e/m_P = r_P/r_c$ hence $r_P = \varepsilon_m r_c$ and therefore, being $r_0 = r_c + r_P$ we should find $r_0 = r_c(1 + r_P/r_c) = r_c(1 + \varepsilon_m)$, yielding

$$r_c = \frac{r_0}{1 + \frac{m_{\mathrm{e}}}{m_{\mathrm{P}}}} = \alpha/4\pi R_H(1 + \varepsilon_m) = \frac{\alpha}{4\pi R_\infty} = 5.291772 \times 10^{-11}\mathrm{m} \tag{77}$$

showing that the *Bohr radius* corresponds to the orbit r_c of the electron charge as observed from the proton].

Now, generalizing the relation $W_0 = h\nu_0$, we may write $W_n = h\nu_n$, therefore the (76) becomes

$$r_n = e^2/8\pi\varepsilon_0 h\nu_n \tag{78}$$

which, because of the (62), becomes

$$r_n = e^2 n^2/8\pi\varepsilon_0 h\nu_0 = r_0 n^2 \tag{79}$$

and then writing the (65) as $m_r v_0^2 = e^2/4\pi\varepsilon_0 r_0$, we obtain

$$v_n^2 = e^2/4\pi\varepsilon_0 r_n\, m_r = e^2/4\pi\varepsilon_0 r_0 n^2 m_r = v_0^2/n^2 \Rightarrow v_n = v_0/n \tag{80}$$

representing the electron orbital speed along any d-orbit r_n, where its frequency becomes

$$f_n = v_n/2\pi r_n = v_0/n2\pi r_0 n^2 = f_0/n^3. \tag{81}$$

Then, because of the ratio $\delta_0 = 2\,\nu_0/f_0 = 1$, and since $\nu_n = \nu_0/n^2$, we also get

$$\delta_n = 2\,\nu_n/f_n = 2\,\nu_0/n^2)/(f_0/n^3) = n \quad (\text{with } n = 1,2,3, \dots.) \tag{82}$$

meaning that each orbit r_n is circular. Besides, referring to Fig. 6, we have

$$r_1 = r_0 + r_e = r_0(1 + r_e/r_0) = r_0(1 + \varepsilon_r), \text{ with } \varepsilon_r \equiv r_e/r_0; \tag{83}$$

$$v_1 = v_0 r_1/r_0 = v_0(1 + \varepsilon_r). \tag{84}$$

2.3. Electron *Radial* Speed, Ionization condition, Electron radius

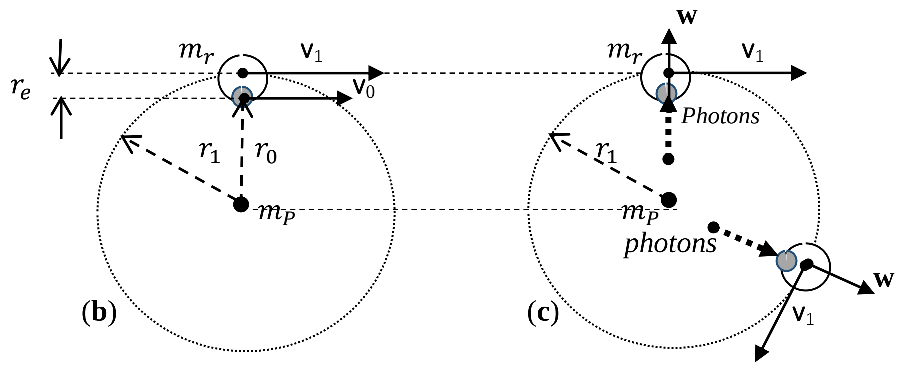


Figure 7. H atom configurations: (**b**) same configuration as the previous Fig. 6-**b**; (**c**) direction of the radial velocity **w** due to the impacts photons-electron.

The Fig.7-(**c**) regards the impact between the incident photon ν_0 and the circling electron**;** according to Eq. (32), and since, see (24), $\gamma = 2h/c^2$, the conservation of momentum along the direction **w**, gives

$$m_0 c\ (= \gamma\, \nu_0 c) = m_r w \Longrightarrow w\ = \gamma\, \nu_0\ c/m_r = 2h\nu_0/cm_r \tag{85}$$

where w is the electron *radial* speed originated by the impact of **one** *photon* during the impact time $T_0 = 1/\nu_0$.

Thus, along the generic orbit r_n, where the number of admitted photons (with frequency ν_n) is n^2, the electron radial speed becomes

$$w_{n^2} = \frac{n^2 2h\nu_n}{cm_r} = \frac{n^2 2h\nu_0}{cm_r n^2} = \frac{2h\nu_0}{cm_r} \tag{86}$$

which is *constant* along every d-orbit r_n. Now, the ionization condition for an electron along its orbit r_n, where its speed is v_1/n, meaning to to escape from its atom on microscopic scale (with zero final velocity), can be expressed by the relation

$$w_{n^2} = v_n = v_1/n \tag{87}$$

therefore we can write

$$\frac{2h\nu_0}{cm_r} = v_1/n \tag{88}$$

and since, see Eq. (84), $v_1 = v_0(1 + \varepsilon_r)$, with $\varepsilon_r = r_e/r_0$ we obtain

$$n = \frac{v_1 cm_r}{2h\nu_0} = \frac{v_0 cm_r}{(1 + \varepsilon_r)2h\nu_0} \tag{89}$$

and given, see Eq. (74), $c = v_0/\alpha$, and since, see Eq. (66), $h\nu_0 = ½\, m_r v_0^2$, we get

$$n = \frac{v_0^2 m_r}{\alpha(1+\varepsilon_r)2h\nu_0} = \frac{h\nu_0}{\alpha(1+\varepsilon_r)h\nu_0} = \frac{1}{\alpha(1+\varepsilon_r)} \cong 137 \quad (90)$$

but n **has to be an integer**, so we can infer n = 137 exact, meaning that the ionization happens along the orbit r_{137}, and therefore we can write

$$137 = \frac{1}{\alpha(1+\varepsilon_r)} \Longrightarrow \varepsilon_r = \frac{1}{137\alpha} - 1 = 0.000262777 \quad (91)$$

and being $r_e = \varepsilon_r r_0$ we find

$$r_e = \varepsilon_r r_0 = r_0\left(\frac{1}{137\alpha} - 1\right) = \frac{\alpha}{4\pi R_H}\left(\frac{1}{137\alpha} - 1\right) = 1.390945 \times 10^{-14}\ \mathrm{m} \quad (92)$$

different from the value claimed by Codata, $r_e' = \alpha^2 a_0 = 2.82 \times 10^{-15}\mathrm{m}$, with a_0 the Bohr radius. Now, the Eq. (84), for n = 137, gives the **following relation**

$$\boxed{v_1 = v_0(1+\varepsilon_r) = \frac{\alpha c}{137\alpha} = c/137} \quad (93)$$

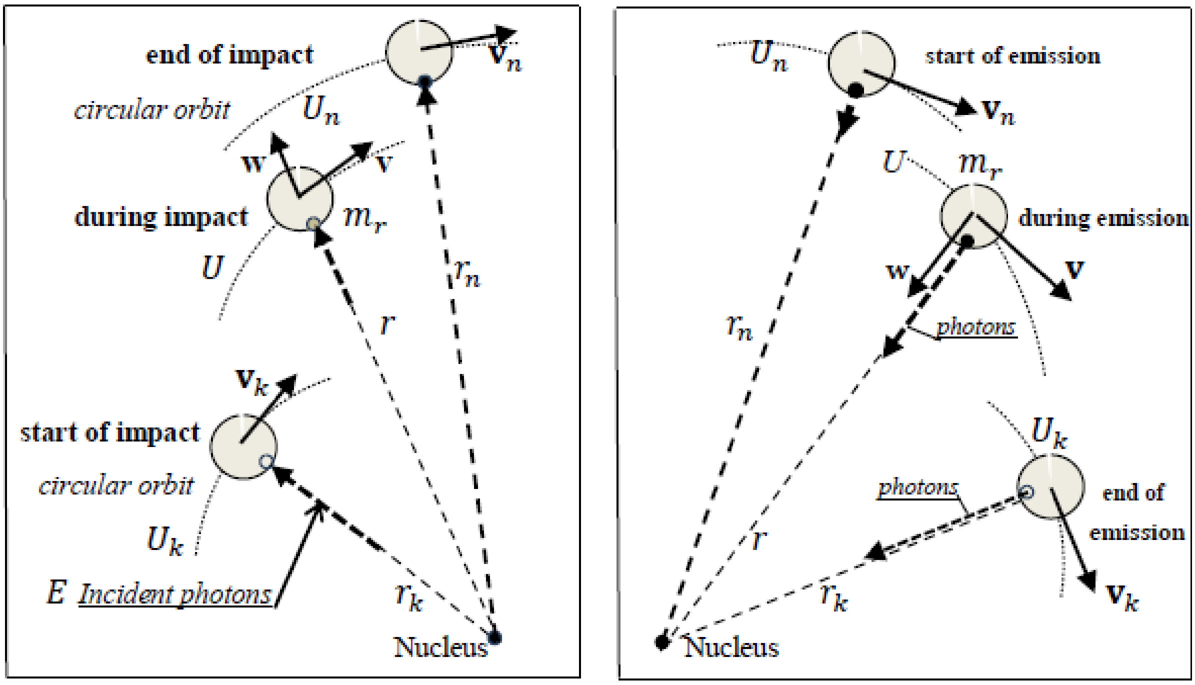
which, on H atom, represents the electron g-s orbital speed along r_1, see Fig. 7.

Summarizing, and referring to Fig. 7, we have:

$\nu_0 = R_\mathrm{H} c$	see Eq.(75), higher frequency of the incident/emitted photons	
$v_0 = \alpha c$	" " (74), electron charge g-s orbital speed	
$r_0 = \frac{\alpha}{4\pi R_\mathrm{H}}$	" " (76) electron charge g-s orbit	
$r_1 = r_0(1+\varepsilon_r) = r_0/137\alpha$	" " (83), (91), electron g-s orbit	(93-a)
$v_1 = \alpha c(1+\varepsilon_r) = c/137$	" " (93) el. g-s orbital speed	
$r_i = r_{137} = r_1/137^2$	" " (79), el. ionization orbit,	
$v_i = v_{137} = v_1/137 = c/137^2$	" "(80), (87), el. orbital speed along the ionization orbit	
$\nu_i = \nu_0/137^2 \cong 175$ GHz	" " (62), photons frequency along the ionization orbit.	

CMB: along the H atom ionization orbit $r_{137}$where the number of absorbed/emitted photons is 137^2, the frequency ν_i ≅175 GHz is very close to the peak of the cosmic microwave background radiation (CMB) having the max intensity [13] in the range 150-200 GHz; at this regard, most cosmologists consider the early Big Bang the best explanation for CMB. On our results, as the hydrogen is the most abundant element in the universe, due to the great number of photons involving the H atom ionization, and since the blue/redshifts of these photons give a continuous value around the CMB peak, we may guess that CMB could be related to the H atom spectrum; in fact, some authors[14],[15] claimed that CMB is originated, in all galaxies, by the conversion of hydrogen to helium.

2.4. H Atom: Absorption/Emission Effect; Claimed Fall of Circling Electrons



(a) – Absorption (**b**) – Emission

Figure 8. Absorption/Emission effect: (**a**) Incident photons are absorbed by the electron which moves toward wider orbit; (**b**) Emission: the electron moves toward inner orbits emitting photons.

The Figure 8-(**a**) represents the photons absorbed by a circling electron, while the side (**b**) their emission. During the impact photons-electron, the total energy *T* of the system is given by

$$T = E + U + K_e + K_r \tag{94}$$

where *E* (= $h\nu$) is the energy of the light (absorbed on conf. (**a**), $U = -e^2/4\pi\varepsilon_0 r$ the electric potential energy of the system electron-proton)**;** K_e (= ½$m_r v^2$) the electron *orbital* kinetic energy; K_r(= ½$m_r w^2$) the electron *radial* kinetic energy related to its radial speed *w* due to the impact photons-electron.

Considering two circular orbits, r_k and $r_n$with $n > k$, at the end of the absorption of the admitted photons, that is along the d-orbit r_n , we have E_n= 0**;** besides, along any circular orbit it is K_r = 0, and therefore, between r_k and r_n, the (94) gives

$$E + U_k + K_{ek} + 0 = 0 + U_n + K_{en} + 0\,. \tag{95}$$

From Eq. (65), in general, we have ½ $m_r v^2 = e^2/8\pi\varepsilon_0 r = -U$ and since K_e = ½ $m_r v^2$, we obtain

$$(U + K_e) = e^2/8\pi\varepsilon_0 r = ½\, m_r v^2 \tag{96}$$

thus the (95) becomes

$$h\nu - ½\, m_r v_k^2 = -\, ½\, m_r v_n^2 \tag{97}$$

and since $m_r v^2 = \frac{e^2}{4\pi\varepsilon_0 r}$ we find

$$h\nu = ½\, m_r v_k^2 - ½\, m_r v_n^2 = \frac{e^2}{8\pi\varepsilon_0}\,(\frac{1}{r_k} - \frac{1}{r_n}). \tag{98}$$

Then, according to (79) we have $r_n = r_0 n^2$ and $r_k = r_0 k^2$, thus we obtain

$$\nu = \frac{e^2}{8\pi\varepsilon_0 h r_0}\left(\frac{1}{k^2} - \frac{1}{n^2}\right) \tag{99}$$

then writing the (66) as $\nu_0 = e^2/8\pi\varepsilon_0 h r_0$, we find

$$\nu = \nu_0\left(\frac{1}{k^2} - \frac{1}{n^2}\right) \tag{100}$$

the known Rydberg formula, representing the frequencies absorbed/emitted by the *photons* between two circular orbits, k and n; thus, given the d-orbit k, all the *remaining* d-orbits are $n = k + 1, k + 2, \ldots, n_i$ with $n_i = 137$ the ionization orbit. In particular, with $n = 136$, we have $\nu_{136} = \nu_0/136^2$, while the next non-circular orbit is $\nu_{136\to137} = \nu_0\left(\frac{1}{136^2} - \frac{1}{137^2}\right)$, and the last circular orbit $\nu_{137} = \nu_0/137^2$.

Regarding, for instance, the Na free atom, since its 1st ionization energy is $W_0 = 5.13$ eV, from (64) we get $v_0 \cong (2W_0/m_e)^{1/2} \cong 1.34\times10^6$ m/s, yielding $c/v_0 \cong 223$ (also a prime number) which is the number of the Na free atom circular orbits, and where $n^2 = 223^2$ is the number of photons necessary for its ionization along the orbit $r_i = 223^2 r_1$ with r_1 its g-s orbit.

2.4.1 Claimed fall of a circling electron into its nucleus: an electrical current, flowing along a circular circuit, emits an electromagnetic radiation (EMR) and, on this basis, it is claimed [16] that a circling electron (because of its charge) should also emit an EMR causing the electron to fall into its nucleus in a short time. On the contrary, on our results, a free electron, (previously removed from its atom and therefore having absorbed the *ionization* photons), under an electrical potential difference, and therefore moving along the electric circuit, when entering into a ionized atom influence, (at that moment the electron charge will return to face the atom nucleus), during its return to a lower orbit, will release the previously absorbed photons. Thus the emission of photons along an electric circuit is not due to the electrons moving along the circuit, but is the effect of the electrons return to their orbits. Moreover, along circular orbits, the electron radial speed is $w = 0$, therefore the absorption/emission of photons cannot happen along circular orbit, that is why the circling electrons are absorbing/emitting photons only *between* circular orbits; at this regard, contrary to the electrons claimed fall, *the photons emission, (at first directed toward the nucleus, see Fig. 8-(**b**) is required, during the electrons re-entry, not to fall into their nucleus*.

2.5 Photoelectric Effect: Number of Involved Photons

Considering now elements on solid state, where the circling electrons have rather fixed orbits, the photons-electron impacts, between the electron orbit r_0 and its extraction orbit $r\to\infty$, according to Eq. (94), valid for every interaction light-matter, gives

$$E + U_0 + K_{e0} + K_{r0} = E' + U_\infty + K_{e\infty} + K_{\text{ae}} \tag{101}$$

where E' is the energy of re-emitted light, $K_{\text{ae}} = ½\, m_e w_{\text{ae}}^2$ the electron kinetic energy after its extraction, (w_{ae} its related radial speed), while the other terms have been defined referring to (94). Now, according to Eq. (96), it is

$$U_0 + K_{e0} = -\tfrac{1}{2} m_e v_0^2 = -W_f \tag{102}$$

with v_0 the electron speed along r_0 and W_f the work function (electron extraction work).

Moreover, at the start of impact it is $w = 0$ giving $K_{r0}(= ½\, m_e w^2) = 0$ while for $r \to \infty$, the electron orbital speed v_∞ tends to 0, hence

$$(U_\infty + K_{e\infty}) = -\,½\, m_e v_\infty^2 \longrightarrow 0 \tag{103}$$

and therefore the (101) becomes

$$E - W_f + 0 = E' + 0 + 0 + K_{\rm ae}. \tag{104}$$

As for the Photoelectric Effect (PhE), the light scatters off an electron ($K_{\rm ae} \geq 0$), but is not re-emitted, hence $E' = 0$; thus, the (104) gives

$$E = W_f + K_{\rm ae} \tag{105}$$

where $W_f + K_{\rm ae}$ is the total kinetic energy transferred from light to electron, that is the sum of the sufficient energy to remove the electron, (W_f), and its energy after extraction ($K_{\rm ae}$).

Then, the (105), with ν_f ($=W_f/h$) the specific threshold frequency, becomes

$$E = W_f + K_{\rm ae} \implies h\nu = h\nu_f + ½\, m_e w_{\rm ae}^2 \tag{106}$$

showing that for $\nu = \nu_f$ there is ionization with $w_{\rm ae} = 0$ (the electron is removed from its atom, but it remains close to it).

At frequency ν_f, the electron radial speed w_f due to the impact of one photon only, see.(85), is

$$w_f = 2h\nu_f/m_e c = 2W_f/m_e c \implies w_f^2 = 2^2 W_f^2/m_e^2 c^2 \tag{107}$$

and since from Eq.(102) $v_0^2 = 2W_f/m_e$, we find

$$w_f^2/v_0^2 = [2^2 W_f^2/m_e^2 c^2]/[2W_f/m_e] = 2W_f/m_e c^2 = v_0^2/c^2 \implies \frac{w_f}{v_0} = \frac{v_0}{c} < 1 \tag{108}$$

and since the ionization may happen when $w_f/v_0 \geq 1$, we infer that n_f photons are needed in order that

$$n_f w_f = v_0 \implies n_f = \frac{c}{v_0} \tag{109}$$

for instance, regarding Na (on solid state), having $W_f \cong 2.36$ eV, and since $v_0 = \sqrt{2W_f/m_e} \cong 9.1\times10^5$ m/s, a number $n_f \cong 329$ of photons is needed at the threshold frequency $\nu_f = W_f/h = 5.7\times10^{14}$ Hz, while for the other elements, being W_f in the range ≅ 2 – 6 eV, one gets $n_f \cong 200 - 360$.

Now, if n_f photons, at frequency ν_f, are sufficient for ionization, then the frequency

$$n_f\, \nu_f \equiv \nu_1 \tag{110}$$

is sufficient for ionization ($w_{\rm ae} = 0$) with one *photon* only; therefore ν_1 is the threshold between PhE and Compton effect (CE) which requires one *photon* only, see next chapter; for instance, as for Na, this effect cannot be observed if $\nu < \nu_1 \cong 1.87\times10^{17}$ Hz.

2.6 Compton effect (CE): one only photon at high frequency is required

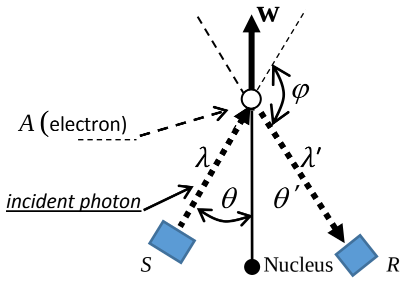


Figure 9.Compton effect: basic components

On Figure 9, *S* is the source of a high frequency light, *A* the impacting electron, *R* the observer of the reflected (*scattered*) photons. Here, an incident photon, parameters c, λ, ν, after the interaction light-matter, is re-emitted at higher *wavelength* λ',while the impacted electron takes on a velocity **w**.

On this effect, due to the high frequency of the light, we may neglect on Eq.(104) the term W_f yielding

$$E - E' = K_{\text{ae}} \Longrightarrow h\nu - h\nu' = K_{\text{ae}} = m_e w^2/2 \quad (111)$$

implying $\nu > \nu'$ hence $T < T'$and therefore $\lambda' = cT' > \lambda$. As for the speed $c'$of the re-emitted photons, we show hereafter that $c'= c$. In fact, the Eq. (111) can be written as

$$E = E' + K_{\text{ae}} \Longrightarrow \tfrac{1}{2}\gamma c^2 \nu = \tfrac{1}{2}\gamma c'^2 \nu' + m_e w^2/2 \quad (111\text{-a})$$

where for frontal impact, see Eq. (32), $w = mc/m_e = \gamma \nu c/m_e$. The incident photon frequency, see Eq. (33), because of w, becomes $\nu' = \nu(1-\beta)$ with $\beta = w/c = m/m_e$ so the (111-a) can be written as

$$c^2 \nu = c'^2 \nu(1-\beta) + m_e \gamma \nu^2 c^2/m_e^2 \Longrightarrow c^2 = c'^2(1-\beta) + m\, c^2/m_e = c'^2(1-\beta) + \beta\, c^2 \quad (111\text{-b})$$

yielding

$$c'^2(1-\beta) = c^2 - \beta\, c^2 = c^2(1-\beta) \quad \Longrightarrow \quad c' = c. \quad (111\text{-c})$$

Let us find hereafter the known *Compton equation*: along the direction normal to **w**, the conservation of momentum (CoM), being, see Eq.(32), **p** = m**c** $=\gamma\nu$**c**, gives

$$\tfrac{1}{2}\gamma\nu c \sin\theta = \tfrac{1}{2}\gamma\nu' c \sin\theta' \quad (112)$$

and since this effect yields $\lambda' \cong \lambda$, hence $\nu' \cong \nu$, as for the value of the electron radial speed w, we can assume $\theta' = \theta$ and also $\nu' = \nu$ and therefore the CoM along the direction **w** can be written

$$\frac{1}{2}\gamma\nu c \cos\theta + \frac{1}{2}\gamma\nu c \cos\theta = m_e w \quad \Longrightarrow \quad w = (m\, c \cos\theta)/m_e\,. \quad (113)$$

Now, from Eq. (111) we have

$$\nu - \nu' = \frac{1}{T} - \frac{1}{T'} = m_e w^2/2h = m_e\,(m^2 c^2 \cos^2\theta)/m_e^2 2h \quad (114)$$

and since, see Eq.(23), $mc^2/2h = \nu$, we get

$$\frac{T' - T}{T'T} = \frac{m\, m\, c^2 \cos^2\theta}{2hm_e} = \frac{m\nu\cos^2\theta}{m_e} \quad (115)$$

then, as $T' \cong T$ we can write $(T' - T)/T^2 = (m\nu\cos^2\theta)/m_e$; thus

$$T' - T = (T^2\gamma\nu\nu\cos^2\theta)/m_e = (\gamma\cos^2\theta)/m_e = \gamma c^2 \cos^2\theta)/c^2 m_e \quad (116)$$

multiplying by c and since $\gamma = 2h/c^2$, we find

$$cT' - cT = \frac{c\ 2h\ \cos^2\theta}{m_e c^2} \Longrightarrow \qquad \lambda' - \lambda = \frac{2h\cos^2\theta}{m_e c} \quad . \tag{117}$$

Now, $\theta = (\pi - \varphi)/2$, hence $\cos\theta\ = \sin(\varphi/2) = \sqrt{(1-\cos\varphi)/2}$, thus $2\cos^2\theta = 1 - \ \cos\varphi$, yielding

$$\Delta\lambda = \lambda' - \lambda = h(1-\cos\varphi)/m_e c \tag{118}$$

the Compton equation. Note that on frontal impact, $\theta = 0^o$ (or $\varphi = 180°$) the (113) which does not include the assumption $T' \cong T$, gives $w/c\ (\equiv \beta) = m/m_e$ so the Eq. (115) can be written

$$T' - T = \frac{T'm}{m_e} = T'\beta \ \Longrightarrow\ T'(1-\beta) = T \quad \Longrightarrow \quad \lambda' = \lambda/(1-\ \beta) \quad \text{(valid on frontal impact)} \tag{119}$$

which equals $\lambda_{R\,out}$ of Eq. (34). On the contrary, the Eq. (118), obtained throughout the assumption $T' \cong T$, for $\cos\varphi = -1$, gives

$$\lambda' = \lambda + 2h/m_e c = \lambda(1 + 2h/m_e c\lambda) = \lambda(1 + mc^2/m_e c\lambda\nu) = \lambda(1 + m/m_e) = \lambda(1+\beta) \tag{120}$$

which is imprecise: in fact, the incident frequency as observed by the electron, because of the Doppler effect, yields $\nu' = \nu(1-\beta)$, so one should get $c' = \lambda(1+\beta)\nu(1-\beta)$different from the expected $c' = c$ which is obtained throughout the exact relation $c' = \lambda'\ \nu' = \frac{\lambda}{1-\beta}\nu(1-\beta)$.

Moreover, the Eq.(113), $w = (\gamma\nu c\ \cos\theta)/\ m_e$, for $\cos\theta = 1$ equals the Eq. (85) which is referred to the impact of one photon, implying, for this effect, the impact of **one** *photon* only.

Still for $\cos\varphi = -1$, from Eq. (118), considered exact for the following results, we get

$$\frac{\Delta\lambda}{\lambda} = \frac{2h}{\lambda m_e c} = \frac{h\nu}{\frac{1}{2}m_e c^2} \quad \text{(valid on frontal impact)} \tag{121}$$

and since, see Eq.(22), $h\nu = \frac{1}{2}m\,c^2$ we find, still on frontal impact

$$\frac{\Delta\lambda}{\lambda} = \frac{m}{m_e} = \frac{\gamma\nu}{m_e} = \beta \qquad \Longrightarrow \qquad \Delta\lambda(=\beta\lambda) = \frac{\gamma c}{m_e} = \frac{2h}{m_e c} = 2\lambda_c \tag{122}$$

with λ_c the Compton *wavelength*.

In short, after the interaction time, see Fig. 10, the photon has at higher length and lower frequency in order that $\nu'\lambda' = \nu(1-\beta)\lambda/(1-\beta) = c$. After the re-emission, the photon parameters are invariant on free path under a constant potential.

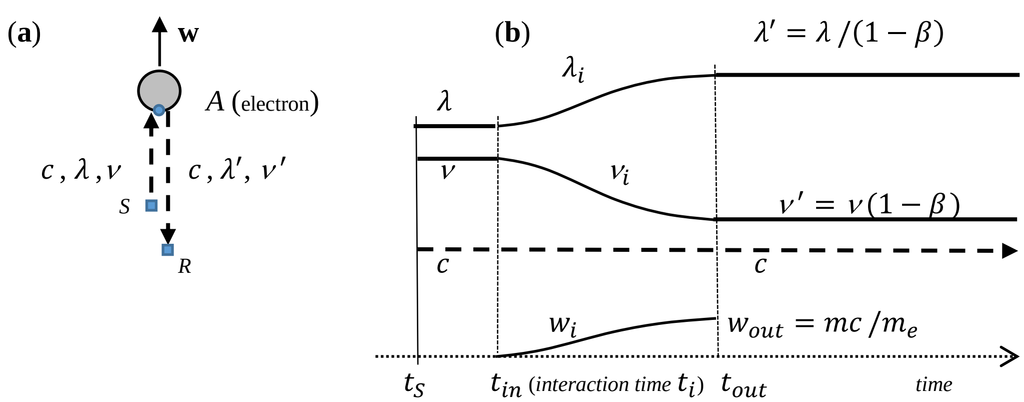


Fig. 10. Compton effect, frontal impact. (**a**) Scheme of impact; (**b**) Scheme of photon parameters during the interaction time.

3. Conclusion

Under the three conditions expressed on the Introduction, we found a new *unified theory* giving unexpected and credible results most of them contrary/different with respect to RT and QM, like, for instance:

- The *measured* constancy of *c* can be explained without the need of the Relativity Theory.
- The speed of light, time dilation and gravitational redshift are function of *U*; at the altitude *h,* we found $c_h = c_0(1 - gh/c_0^2)$, Eq.(37).
- The Planck's constant, see Eq. (25), is function of *c*; its inverse (h^{-1}) corresponds to the number of photons $n_\gamma = h^{-1}$, emitted in 1 s by a source of unitary power, Eq. (31).
- The number of rays emitted by a source of power *P* is $n_r = P/h\nu$, Eq. (30).
- The circling electrons do not emit EMR; they do it during their re-entry into ionized atoms.
- The quantum numbers are related to the integer number of absorbed/emitted photons by impacted electrons.
- On H atom, the electron charge ground-state (g-s) orbit observed from the proton, Fig. 6-b, is $r_0 = \alpha/4\pi R_H$, Eq. (76), while its speed is $v_0 = \alpha c$ with α the fine structure constant. Still on Fig. 6-b, the electron g-s orbital speed is $v_1 = \frac{c}{137}$ exact, Eq. (93); while its orbit is $r_1 = r_0/137\alpha$, Eq. (93-a).
- The number of photons needed for the H atom ionization along its ionization orbit $r_i = 137r_0$, is 137^2.
- The impact photons-electron, giving an electron radial speed is $w = \frac{2h\nu}{cm_e}$, Eq. (85).
- The number of photons required for the photoelectric effect is in the range $n \cong 200 - 360$ depending on W_f, while their number required for the Compton effect is 1 (one) at a specific frequency.

An updated Harvard tower experiment would support our results: the Eq. (48) shows that the direction of the *compensation* velocity (to restore the resonance source-detector), as predicted by the Relativity is contrary to our results; in fact, on the Pound-Rebka-Snider experiments, this direction was not taken in consideration.

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