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Evidences for a Unified Physics, in Full Accordance with the Newtonian Laws

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Abstract

We show that the speed of a longitudinal-extended, elastic (variable length), and massive particle, emitted by a source during an *emission time T*, at speed *u* (escape speed from all the masses in space), is invariant for every *real* measurement, (intending a measurement requiring an interaction light-matter), in spite of any reciprocal motion source-Observer. Thus we may argue that the light has to be composed of such particles (*photons*) moving at speed $c = u$. Compliance of these *photons* with Newtonian mechanics is shown for many effects, (like the Doppler effect, redshift, time dilation, etc.), highlighting the differences versus the Relativity. In the 2nd part, on the assumption that the electron charge can be considered as a point-particle fixed to the electron surface, always facing the atom nucleus during the electron revolution, we revised the light-matter interaction, showing that it only depends on the *particular* impacts between these *photons* and the circling electrons: for instance, on H atom, we found 137 circular orbits only, the last one being the ionization orbit, where the electron orbital speed becomes $v_i = c/137^2$. [*Classical* mechanics implies that orbiting electrons produce an electro-magnetic radiation causing their fall into the nucleus: on Section 3.5, the reason why the electron *circular* orbits are stable].

Keywords

Doppler Effect for the Light, Harvard Tower Experiment, Gravitational Redshift, Time Dilation, Compton Effect

1. Introduction

This paper is based on following assumptions:

I. Finite mass of the universe, (implying a finite value of the *total* gravitational potential *U*).

II. Light composed of longitudinal-extended elastic particles moving at speed $c = u$.

On above bases we obtain, among others, these following results:

a) The relation $u = (-2U)^{1/2}$, where u is *total* escape speed, that is the escape speed from all the masses (in space); then we assumed $c = u$.

b) The measured constancy of c, under a constant potential U, (like on Earth), for every Observer.

c) Doppler effect (DE) equations for the light, slightly different from the relativistic ones.

d) Regarding the Harvard Tower Experiment, the *compensating velocity*, (to restore the resonance source-absorber), see Section 2.4, has same value but contrary direction with respect to the one predicted by the Relativity.

e) On Earth, at height h, (e.g. at GPS satellites level), it is shown that a source (of light) emits at a lower frequency, inducing atomic clocks to run faster.

f) High redshifts, related to *far* sources, depend on the increase of c (as well as the increase of the *photons* length λ) during the path of light toward the Earth, (where $|U_o| \gg |U_{\to\infty}|$).

In the 2nd part, we show the interaction between our *particles* and circling electrons; we *revised* the electron structure, assuming the electron charge as a point-particle, (facing the atom nucleus during the electron orbit), which turns out to be the *impact point* between *photons* and electron; some results:

g) On H atom there are only $n = 1, 2, \cdots, 137$ electron circular orbits; along each of them, n is also the number of admitted *photons*. We show that $2\nu_0/\nu_{e0} = \alpha(cm_r/2hR_H)^{1/2} = 1$ **(exactly)** with ν_0 the *photons* admitted frequency along the ground-state orbit r_0 (different, because of our *new* atom structure, from the Bohr radius) and ν_{e0} the frequency of the electron reduced mass m_r along r_0, with α the fine structure constant.

h) On Photoelectric effect, the number of *photons* hitting the electron varies from n_f to $n_f^{1/2}$ where n_f is related to the specific threshold frequency ν_f $(= W_f/h)$. For instance, it is shown that, as for Caesium (having $W_f \cong 2$ eV), one gets $n_f = 361$.

i) On Compton Effect, the number of *photons a*dmitted is one We point out that we got the Compton equation via *our* Doppler effect for the light, different from the relativistic Doppler Effect.

2. Part 1

2.1. *Total* Escape Speed

This argument has been widely treated on Section 2 of our previous paper [1]. Here we remember:

$$u = \sqrt{-2U} = \sqrt{2MG/s} \tag{1}$$

escape speed of a particle m at a distance s from the mass M, with U the gravitational potential acting on m; if M is a real mass, s becomes the distance m-C_p with C_p the Centre of Potential of M, that is the point where $|U|$ has the max value), while the *es-*

cape velocity of m which has to be referred to C_p,

$$\mathbf{v}_{Cpm} = \mathbf{u} \tag{2}$$

may be called as *absolute escape velocity* of m, *absolute* as referred to C_p; then

$$U_{1,2} \equiv U_1 + U_2 = \left(-M_1 G/s_1\right) + \left(-M_2 G/s_2\right) \tag{3}$$

is the potential due to two masses; then the escape speed from two masses becomes

$$u_{1,2} \equiv \sqrt{-2U_{12}} = \sqrt{\left(2M_1 G/s_1\right) + \left(2M_2 G/s_2\right)} \tag{4}$$

yielding

$$u_{1,2}^2 = u_1^2 + u_2^2 \tag{5}$$

thus

$$u = \sqrt{\sum u_n^2} = \sqrt{-2U} = \sqrt{2\left(\sum M_n G/s_n\right)} \tag{6}$$

is the *total* escape speed, with U the *total* potential; $\mathbf{u}$ (*absolute* escape velocity) *has* to be referred to the centre of potential of all the masses, C_p. Now, if S is a Source emitting a particle m, we may call

$$\mathbf{v}_{Sm} = \mathbf{u} \tag{7}$$

as *relative* escape velocity of m from S, (*relative* as $\mathbf{u}$ is referred to S). We assume now

$$c \equiv u = \sqrt{-2U} \tag{8}$$

showing that c depends on U; on Earth, U is practically constant, see the final "Conclusions".

Equation (8) is supported by a **cosmological reason**, as better explained between the Equation (5) and Equation (6) on [1]: in short, $c > u$ implies the masses dispersion, $c < u$ implies a gravitational collapse, where as $c = u$, appears to be the right speed of the light to avoid the two said events (collapse or dispersion).

2.2. Invariance of *c* for Every Observer, Under the Newtonian Laws

-This chapter is a deep revision/improvement of chapter4 of our previous paper [1]-

We assume now the light as composed of particular *particles* (*photons*), giving a Newtonian reason to the (apparent) constancy of c, defined as follows:

"Longitudinally-extended, elastic and massive particles having speed equal to the *total* escape speed u, and moving along rays, (continuous succession of *photons*)".

(More *photons* emitted by a source, during an emission time T, need an equal number of rays).

Along each ray, every *tail* of a *photon* corresponds to the *front* of the next *photon*.

Now, on Figure 1, let S be a Source, (moving from an Observer O with velocity $\mathbf{v}_{OS}$), starting to emit, at $t = 0$, (when S is coincident with O), a *photon* (with *front* A), along the direction S-O; therefore

$$\mathbf{v}_{OA} = \mathbf{u} \tag{9}$$

represents, see Equation (7), at $t = 0$, the *relative* escape velocity of the *front* A from O, while the velocity of the front A, with respect to S, that is $\mathbf{v}_{SA}$, turns out to be

$$\mathbf{v}_{SA} = \mathbf{v}_{SO} + \mathbf{v}_{OA} = \mathbf{u} - \mathbf{v}_{OS} \tag{10}$$

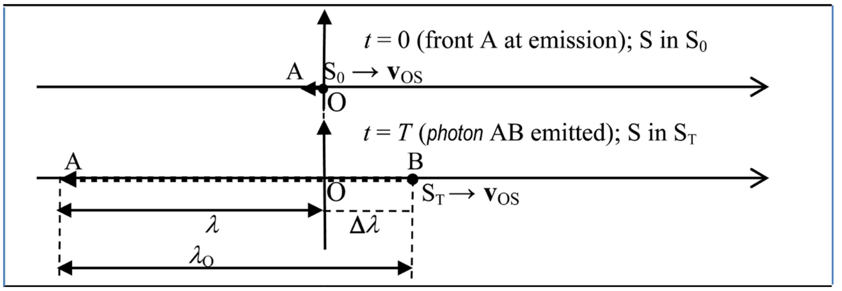

Figure 1. The source S, in motion from the observer O, emits the photon AB.

Now, being S_T be the position of S at $t = T$, we get

$$\boldsymbol{\lambda}_O = \mathbf{v}_{SA} T = (\mathbf{u} - \mathbf{v}_{OS}) T = \boldsymbol{\lambda} - \mathbf{v}_{OS} T \tag{11}$$

where $\boldsymbol{\lambda}_O$ is the *photon* AB emitted with S in motion from O, whereas $\boldsymbol{\lambda}$ ($\equiv \mathbf{u} T$) would be the *photon* AO if, during T, $\mathbf{v}_{OS} = 0$. Thus, at $t = T$, if the source is *receding* from the front A, as in Figure 1, the *photon* length λ_O, (for the Observer O), from Equation (11), becomes

$$\lambda_O = uT + v_{OS} T = \lambda_O + \lambda = \lambda(1+\beta), \text{ (with } \beta = v_{OS}/u\text{)} \tag{12}$$

where $v_{OS} = |\mathbf{v}_{OS}|$, with $\Delta\lambda$ ($= v_{OS} T$) the path O-S_T covered by S during T. For instance, if $v_{OS} = 0$, the (12) gives $\lambda_O = uT = \lambda$ with λ the *photon* length as seen by S.

The Equation (12) shows that the length of a *photon* during its emission, given u and T, depends on $\mathbf{v}_{OS}$, meaning that Observers in reciprocal motion state different length for the same *photon*.

Now, referring to an Observer O, the speed of a *photon*, (since its length could vary), has to be defined considering its length λ_O referred to its transit time T_O, leading to

$$u_O \equiv c_O = |\boldsymbol{\lambda} - \mathbf{v}_{OS} T| / T_O = \lambda_O / T_O \tag{13}$$

Returning to Figure 1, the *transit time* T_O of the *photon* AB, for the Observer O, is given by the time the front A needs to cover the path λ, that is T ($= \lambda/u$), plus the time the tail B needs to cover the path $S_T - O = \Delta\lambda$ ($= v_{OS} T$) which is $\Delta T = v_{OS} T/u$, giving

$$T_O = T + \Delta\lambda/u = T + v_{OS} T/u = T(1+\beta) \text{ (with } \beta = v_{OS}/u\text{)} \tag{14}$$

Thus, see Equation (13), referring to the Observer O, the speed of the *photon* AB becomes

$$u_O = \lambda_O / T_O = \lambda(1+\beta)/T(1+\beta) = \lambda/T (\equiv c) \tag{15}$$

showing that c is invariant, under the Newtonian laws, in spite of any speed Source-Observer.

Anyhow, a *photon*, *once emitted*, has a constant length for every Observer, hence its speed has to vary for Observers in reciprocal motion, but we point out that the measurements of c via the method d/t implies that the light has to cross (or to be reflected by) an Observer O (taking the initial time); this means that O becomes the source S of *photons* emitted by a source at rest with O(v_{OS} = 0) who will state a length $\lambda_O = \lambda$, a transit time $T_O = T$ giving to c a constant *measured* value.

Along one ray, *the frequency* of *photons*, for an Observer O, is their number crossing O during a time t, that is $\nu = n/t$; thus for $t = T_O$, (*transit time* of one *photon*, for an Observer O), from Equation (14),

$$\nu_O \left(=1/T_O\right) = 1/T\left(1\pm\beta\right) = \nu/\left(1\pm\beta\right) \tag{16}$$

with the sign + when S and O, during the emission, are receding from each other. We point out that for $\beta = 0$, ($v_{OS}/u = 0$), the *photons* frequency as stated by a source S (ν_s), has to be equal to the one stated by O (ν_O), which is also valid if O and S belong to different potential, (e.g., the equality of the number of balls falling from the top of a tower with respect to an Observer at the tower base), and this, for $v_{OS} = 0$, always implies $\nu_s = \nu_O$. Figure 1, as well as Equations ((12) and (16)) represent the *longitudinal Doppler effect* for the light while, in general, this effect, with α the angle between the direction of S and OS, (and with S receding from O), see Figure 2, can be written as

$$\lambda_O = \lambda + v_{OS}T\cos\alpha = \lambda\left(1+\beta\cos\alpha\right) \quad (\text{with} \quad \beta = v_{OS}/c) \tag{17}$$

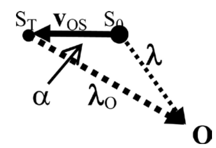

Figure 2. Doppler effect.

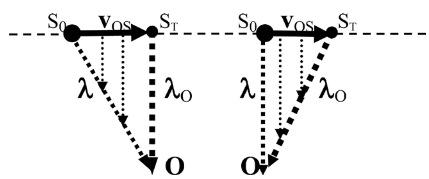

Figure 3. Transverse doppler effect.

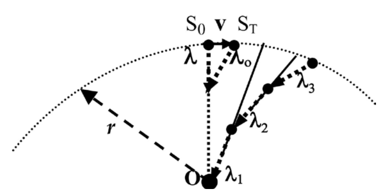

Figure 4. Source circling around the observer O.

As for the *Transverse Doppler effect*, see Figure 3, in general, we have

$$\lambda_O = \sqrt{\lambda^2 \pm \left(v_{OS}T\right)^2} = \lambda\sqrt{1\pm\beta^2} \tag{18}$$

As for *a source circling around an Observer* O, see Figure 4, it is always $\lambda_O > \lambda$ as follows:

$$\lambda_O = \sqrt{\lambda^2 + \left(v_{OS}T\right)^2} = \lambda\sqrt{1+\beta^2} = \lambda\sqrt{1+\omega^2 r^2/c^2} \tag{19}$$

while their *photons* transit time is

$$T_{\mathrm{O}} = T\sqrt{1+\beta^2} = T\sqrt{1+\omega^2 r^2/c^2} \tag{20}$$

where r is the orbit radius, ω the angular speed, yielding, to every *photon*, the speed $c_{\mathrm{O}} = c$.

2.3. Physical Characteristics of These *Photons*

Also this argument has been widely treated on our previous paper [1]: here we point out that as the energy of light $E = mc^2$ is valid for any mass, it has to be also valid for the light (massive on our bases) and therefore, writing $E = \frac{1}{2}mc^2 + \frac{1}{2}mc^2$ we have to argue that each *photon* is provided with an *internal* energy $K_{\mathrm{i}} = \frac{1}{2}mc^2$ equal to its kinetic energy K_{c}. Toward the infinity, (where $c_\infty \to 0$) both K_{c} and $K_{\mathrm{i}} \to 0$ and therefore, since $E = h\nu$,

$$E = K_{\mathrm{c}} + K_{\mathrm{i}} = \frac{1}{2}mc^2 + \frac{1}{2}mc^2 = mc^2 = h\nu \tag{21}$$

represents the energy of one *ray of light*, (where *photons* are flowing) and where

$$m = h\nu/c^2 \equiv \gamma\nu \ (\mathrm{kg}) \tag{22}$$

is the mass of light, having frequency ν, passing along one ray in 1s, while the constant

$$\gamma \equiv h/c^2 = m/\nu = 7.372495\times10^{-51} \ \mathrm{kg}\cdot\mathrm{s} \tag{23}$$

where

$$h = \gamma c^2 = mc^2 T \tag{24}$$

thus the Planck's constant *turns out to be the energy of one photon*.

Now, since m is the mass of light passing along one ray in 1s, the term $n_{\mathrm{r}}mc^2$, with n_{r} the number of rays emitted by a source S, becomes the energy emitted by S in 1s; this unitary (unit of time) energy shall be equal to the supplied power P during 1s,yielding

$$n_{\mathrm{r}}mc^2 = P\ , \tag{25}$$

therefore

$$m_{\mathrm{tot}} = n_{\mathrm{r}}m = P/c^2 \tag{26}$$

is the total mass lost per second by a source of light; e.g. for a 1W lamp, we get $m_{\mathrm{tot}} = P/c^2 \cong 1.1\times10^{-17} \ \mathrm{kg}\cdot\mathrm{s}^{-1}$, while the number n_{r} of rays is

$$n_{\mathrm{r}}\left(= m_{\mathrm{tot}}/\gamma\nu\right) = P/c^2\gamma\nu = P/h\nu \tag{27}$$

in our case, $n_{\mathrm{r}} \cong 3 \times 10^{18}$ rays. Then, for a given power P, the higher is the frequency, the lower is the number of rays, as shown by (27) written as $n_{\mathrm{r}}\nu = P/h$. The number of *photons* emitted in 1s is

$$n_\gamma\left(= n_{\mathrm{r}}\nu\right) = P\nu/h\nu = P/h \tag{28}$$

which, for $P = 1$ W, gives $n_\gamma = h^{-1}$ (=1.5 × 10^{33} *photons*/s), thus the inverse of Planck's constant turns out to be the number of *photons* emitted in 1s by a source of unitary power, and this great number of *photons* allows the light to be treated as a wave.

Now, during inelastic impacts, (like on absorption or photoelectric effetcs), both kinetic and internal energy of the light are involved, so the momentum transferred to the electron is

$$\mathbf{p} = 2m\mathbf{c} = 2\gamma\nu\mathbf{c} = 2\gamma\mathbf{c}/T \quad (29)$$

while, during elastic impacts, the momentum transferred to the electron is

$$\mathbf{p} = m'\mathbf{c} = \gamma\nu'\mathbf{c} = \gamma\mathbf{c}/T' \quad (30)$$

either for *incident* or for *reflected photons*, with T' the total impact time for this interaction, as we show on Section 3.7, Compton effect; at this regard, via the (30), as well as via *our* Doppler effect equation, see (12), we get the Compton equation, which can not be obtained by the Relativity via their Doppler effect equations.

2.4. Re-Visitation of the Harvard Tower Experiment (HTE), Time Dilation, Gravitational Redshift

Also this argument has been widely treated on our previous paper [1]. Here the main results: referring to **Figure 5(a)**, where h is the tower height, and M_E is the mass of Earth, writing the Equation (8) as $c^2 = -2U$, we can obtain

$$(c_h - c_0)/c_0 = -\Delta U/c_0^2 = -M_E Gh/r_h r_0 c_0^2 \cong -gh/c_0^2 \quad (\text{valid for } r_h \cong r_0) \quad (31)$$

that is the variation of c from the tower base to its top, where c_0 and c_h are the corresponding values of c, $\Delta U\left(=U_{Eh} - U_{E0}\right)$ is the variation of potential; hence $c_h < c_0$, with $c_h = c_0\left(1 - gh/c_0^2\right)$.

Let now S be a Mossbauer source and A a related absorber, both, for instance, at the tower base, therefore in resonance. Then, see **Figure 5(b)**, taking A to the top, and since A and S are now at rest, the frequency of the *photons* emitted by S, has to be equal to the one observed by A, that is $\nu_h = \nu_0$, therefore the Equation (31), as for the *photons* emitted by S, can be written as

$$\Delta c/c_0 = \Delta\lambda/\lambda_0 = -gh/c_0^2 \quad (32)$$

and since $c_h < c_0$, it must be $\lambda_h < \lambda_0$, so, *contrary to* Relativity, A observes a blue-shift effect.

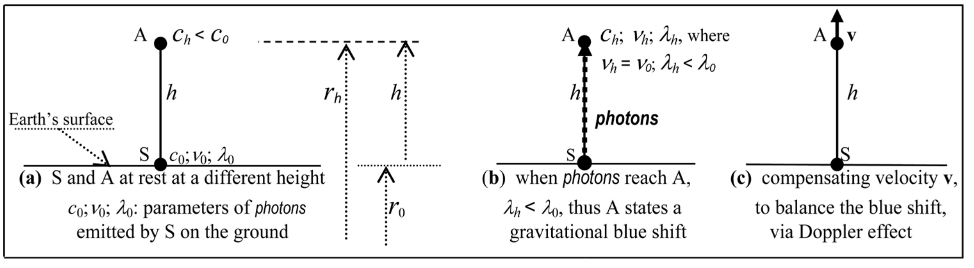

Figure 5. Harvard tower experiment (HTE) scheme; source at the base, our results.

Thus, to restore the resonance via Doppler Effect (DE), S and A, see **Figure 5(c)**, have to recede from each other, in order that the *photon* length should increase, see

Equation (12), from λ_h to $\lambda_0 = \lambda_h(1+\beta)$ with $\beta = v_{AS}/c \equiv v/c$, so, equating the *photon* length variation ($\Delta\lambda/\lambda = -v/c$ due, see (17), to DE), to $\Delta\lambda/\lambda$, due to the altitude, as given by (32), we get $v/c = gh/c_0^2$, yielding

$$v = gh/c_0 = 7.5\times10^{-7}\ \text{m/s} \quad (\text{for} \quad h = 22.5\ \text{m}). \tag{33}$$

This value is also predicted by GR which, implying a decrease of ν for the light moving from the base to the top, predicts an opposite direction of **v** with respect to the one shown on Figure 5(c); at this regard, Pound-Rebka and Pound-Snider, [2] [3] [4], gave no clear indication about the direction of the compensating velocity.

Moreover, see Figure 5(b), with S on the base, emitting upward, A goes out of resonance and since on our bases $\nu_h = \nu_0$, the *non-resonance is physically related to a variation* of λ.

Now, see Figure 6(a), with A on the base, taking S to the top, the experience shows that the absorber goes out of resonance. Indeed, with S on the top, the (31) shows $c_h < c_0$, but what about the initial parameters of the *photons* emitted in altitude, ν_h and λ_h?

Well, see Figure 6(b), since S and A are at reciprocal rest, the frequency of the *photons* arriving to the base, is $\nu_{h\text{-}0} = \nu_h$, hence along the path top-base, the *photon* length $\lambda_{h\text{-}0}$ has to increase (following the increase of c from c_h to c_0); thus we have to argue that taking the source on top, see Figure 6(a), the *photons initial* length must be $\lambda_h = \lambda_0$, in order that after the path top-base, it becomes $\lambda_{h\text{-}0} > \lambda_0$ (inducing the absorber to go out of resonance).This implies

$$\nu_h = c_h/\lambda_h = c_0\left(1-gh/c_0^2\right)/\lambda_0 = \nu_0\left(1-gh/c_0^2\right) = \nu_0\left(1-\Delta U/c_0^2\right) \tag{34}$$

showing that, taking S to the top, $\nu_h < \nu_0$. Now, along the path top-base, $\Delta\lambda/\lambda$ has opposite sign with respect to (32), yielding $(\lambda_{h-0}-\lambda_h)/\lambda_h = gh/c_0^2$, and since $\lambda_h = \lambda_0$, we get

$$\lambda_{h-0} = \lambda_h\left(1+gh/c_0^2\right) = \lambda_0\left(1+gh/c_0^2\right) \tag{35}$$

showing an increase of λ from the top to the base. Hence the absorber, on the base, will state a red-shift so, to compensate it via Doppler shift, see Figure 6(c), S and A have now to move relative to each other; *on the contrary, according to Relativity, A and S should recede from each other.*

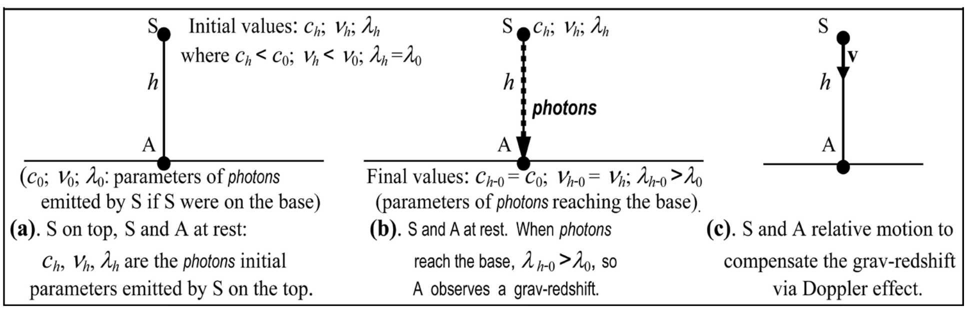

Figure 6. Harvard tower experiment scheme; source on the top, our results.

Time dilation: Atomic clocks in altitude (h-clocks) are ticking *faster* than identical clocks on the ground (g-clocks): indeed, on our bases, at height h, see (30), we have

$(c_h - c_0)/c_0 = -\Delta U/c_0^2$, while taking a clock to a GPS satellite, see also **Figure 6(a)**, from (34), one finds

$$T_h = T_0\big/\left(1-\Delta U/c_0^2\right) \tag{36}$$

with $T_h = 1/\nu_h$ the counted time of one *photon* emitted by a *h*-clock, while T_0 to a g-clock. Thus the variation of the counted time between the two clocks, for every emitted *photon*, becomes

$$T_{\text{ph}} = T_h - T_0 = \left[T_0\big/\left(1-\Delta U/c_0^2\right)\right] - T_0 = \left(T_0\Delta U/c_0^2\right)\big/\left(1-\Delta U/c_0^2\right) \tag{37}$$

Now, the frequency of *photons* is their number emitted in 1 s along one ray, therefore the term

$$n_{1\text{s}} \equiv \nu_0 t_{1\text{s}} \quad (\text{with} \quad t_{1\text{s}} = 1\,\text{s}) \tag{38}$$

is the number of *photons* (atomic transition of Cs 137) that constitute a one-second, so that

$$\nu_h \Delta T_{\text{ph}} = \Delta n_{1\text{s}} = \nu_0\left(1-\Delta U/c_0^2\right)\left(T_0\Delta U/c_0^2\right)\big/\left(1-\Delta U/c_0^2\right) = \nu_0 T_0 \Delta U/c_0^2 = \Delta U/c_0^2 \tag{39}$$

is the variation of$n_{1\text{s}}$ emitted in1 s by a *h*-clock; now, see (31), $\Delta U = M_{\text{E}} Gh/r_h r_0$ and since$r_h \cong 26{,}600$ km, $r_0 \cong 6400$ km, with $h \cong 20{,}200$ km, the increase of counted time in one day (ΔT_{1d}) of a *h*-clock, with respect to a g-clock, becomes

$$\Delta T_{1d} = \Delta n_{1\text{s}} \times 86400\,\text{s} = 86400\,\Delta U/c_0^2 = 45.5\,\mu\text{s}. \tag{40}$$

Now, being $v = 2(2\pi r_h/86{,}400 = 3870$ m/s the orbital speed of GPS satellites, (corresponding to two orbits/day), it turns out that the variation of the counted time, between a *h*-clock and an Observer *E* at the centre of Earth, due to their relative motion, is given by Equation (20) which, in our case, with $\beta = v/c$, becomes

$$T_E = T_h\sqrt{1+\beta^2} \cong T_h\left(1+\beta^2/2\right) \quad (\text{valid for} \quad v \ll c) \tag{41}$$

with T_E the *photon* counted time for the Observer E; then, with v_0 the Earth's rotational speed, and since $\left(v_0/c\right)^2 \ll \left(v/c\right)^2$, we can write $T_0 \cong T_E$ with T_0 the counted time of one *photon* for a g-clock; so, the difference between the two transit times T_h and $T_0 \cong T_E$ given by (41), is

$$\Delta T'_{\text{ph}} = T_h - T_E \cong T_h - T_0 = -T_h\beta^2/2 \tag{42}$$

Then, as above, $\nu_h \Delta T'_{\text{ph}} \equiv \Delta n'_{1\text{s}} = -\nu_h T_h \beta^2/2 = -\beta^2/2$ is the variation of the number of *photons* emitted by a *h*-clock in 1 s; so the variation of the counted time, in one day, becomes

$$\Delta T'_{1d} = -\left(\beta^2/2\right)86400\,\text{s} = -7.2\,\mu\text{s} \tag{43}$$

showing a decrease of the counted time for a g-clock due to the clocks relative motion; hence

$$\Delta T_{tot1d} = \Delta T_{1d} + \Delta T'_{1d} = 38.3\,\mu\text{s/day} \tag{44}$$

which is also predicted, (with different reason), by GR. To prevent the two said effects, before launching, the daily counted time ($T_{1\text{d}}$) of clocks, has to be decreased by ≅38 μs;

this adjustment is sufficient to obtain synchronization between *h*-clocks and g-clocks: indeed, on our bases, the frequency of *photons*, emitted by a *h*-clock, does not change along the *straight* path satellite-ground, whereas as for the Relativity, because of its predicted increase of the frequency along the *straight* path satellite-ground, a g-clock should go, (for this 3rd effect), out of synchronization.

Gravitational redshif

Referring to our previous paper [1], we summarize, hereafter, the differences between the Relativity and our results: as for the Relativity, the only way to explain high cosmological redshifts is the Doppler effect, (which implies an *incredible* universe expansion at a speed $v_u \cong c$), whereas, on our results, disregarding the reciprocal motion between a (far) source and an Observer on Earth, which implies $\nu = \nu_0$, we get $c/\lambda = c_0/\lambda_0$, where ν_0, c_0 and λ_0 are the values on Earth, showing that for $c_0 > c$ it has to be $\lambda_0 > \lambda$, that is a red shift. In general, the shifts observed on Earth can be therefore expressed as

$$z \equiv \Delta\lambda/\lambda = \Delta c/c = (c_0 - c)/c = (c_0/c) - 1 = \sqrt{U_0/U} - 1 \tag{45}$$

with U_0 the potential on Earth, U the one on the source. Thus, apart from Doppler effects, z turns out to be the variation of c (as well as λ) during the path of light toward a different potential. For $s < \cong 45$ Mpc, [5], (corresponding to $-0.01 < z < \cong 0.01$) if U (potential on the source) is, in *absolute value*, higher than the potential on Earth U_0, the (45) gives, on Earth, $z < 0$ (blue shift), and vice versa for $|U| < |U_0|$; thus, for $s < \cong 45$ Mpc, these red/blue shifts indicate that the potential, may increase or decrease. In the range $\cong 0.01 < z < \cong 0.20$, (where z follows the Hubble's law), the (45), written as

$$U = U_0/(1+z)^2 \cong U_0/(1+2z) \cong U_0(1-2z) \quad (\text{valid for } z \ll 1) \tag{46}$$

shows that, for $z \ll 1$, U depends linearly on z, as Hubble's law;then, for $s \to \infty$, $U \to 0$, hence $z \to \infty$, see Table 1.

Table 1. Calculated values of U and c related to the observed shifts on Earth.

blue/redshift	z	s (Mpc)	$U/U_0 = 1/(z+1)^2$	$U/U_0 \cong 1-2z$	$c/c_0 = 1/(z+1)$
blue/red shift	$-0.01 \to 0.01$	<≅45	0.98 - 1.02	0.98 - 1.02	0.99 - 1.01
red shift	≅0.01	≅45	0.98	0.98	0.99
red shift	0.20	900	0.69	0.60	0.83
red shift	1		0.25		0.50
red shift	$\to\infty$	$\to\infty$	$\to 0$		$\to 0$

For $s > \cong 45$ Mpc, z is always positive, hence we may argue that our galaxy is close to the centre of potential C_p of all the masses, (where $|U_{Cp}|$ has the max value), practically close to the middle of the masses of universe.

3. Part 2—Interaction Light-Matter

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

On our basis, (light composed of our *photons*), the interaction light-matter requires that to move a circling electron toward outer orbits, the impact *photon*-electron has to occur, see Figure 7(a), in a *radial way*, (giving origin to the radial velocity **w**), otherwise, some impacts could cause the electron fall into the nucleus, due, for instance, to an impact where *photons*-electron have contrary direction.

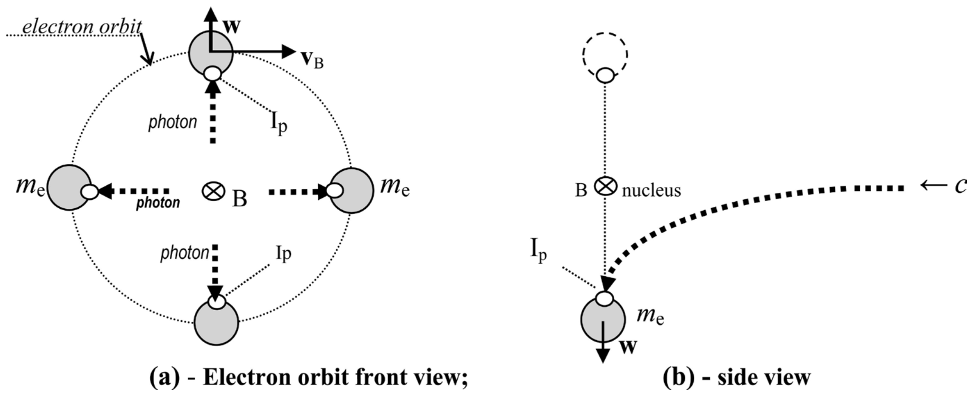

Figure 7. *Photon*-electron Impact point (I_p) and electron *radial* velocity w.

To be radial, the impact must occur in a specific point (*Impact Point*, fixed to the electron) which, *during the electron revolution*, has to face its nucleus, (up to its removal), giving to the electron one rotation every revolution. Thus we can infer that the electric charge of the electron, has to correspond to the Impact Point (I_p), and we have also to argue that each *photon front* is provided with a positive charge, while its *tail* with an equal negative one.

Moreover, in case of more impacts, as it happens, for instance, on Absorption/ Emission effect, where the impacts move a circling electron toward higher orbits, the impacts *photons*-electron have to occur all around the electron orbit, thus the impacting *photons* have to approach the nucleus, as shown on Figure 7(b), perpendicularly to the electron orbit plane, providing, to the electron, a radial velocity **w**.

3.2. H Atom Parameters (On Our Bases) and Meaning of Its Quantum Numbers

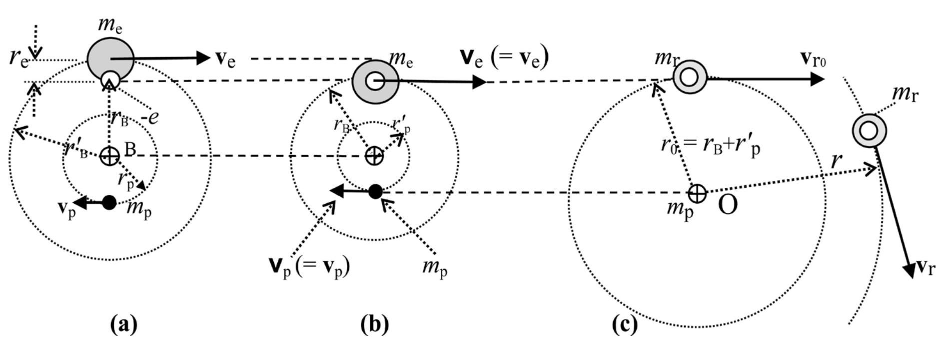

Figure 8. H atom configurations, (on our bases), at constant total energy. (a) Observed from the electron-proton common centre of gravity B; (b) Ditto, with the electron barycentre now coincident with its proper charge; (c) Observed from the proton fixed as origin, orbited by the electron having now a reduced mass.

The Figure 8(a) represents an H atom with both the electron mass m_e and the proton mass m_p circling around B (centre of mass of the system electron-proton), and where, on our bases:

r_B is the ground-state orbit of the electron charge,

r_e the electron radius,

r_p the proton ground-state orbit,

$v_e = |\mathbf{v}_e|$, the electron ground-state (orbital) speed,

v_p the proton ground-state speed.

Hence, the ground-state orbit of the electron barycentre turns out to be

$$r'_B = r_B + r_e = r_B\left(1 + r_e/r_B\right) = r_B\left(1+\varepsilon_r\right),\ (\text{with } \varepsilon_r \equiv r_e/r_B). \tag{47}$$

Now, to apply *properly* the equality between the electron centrifugal force and the Coulomb force, we have to consider the configuration (**c**) where the electron reduced mass

$$m_r = m_e\big/\left(1 + m_e/m_p\right) = m_e\big/\left(1+\varepsilon_m\right)\ \ (\text{with } \varepsilon_m = m_e/m_p), \tag{48}$$

is circling around the proton fixed as origin (O). Now, the *total* energy of the configurations (**a**) and (**b**) are:

Configuration (**a**), where $m_e v_e = m_p v_p \Rightarrow v_p = m_e v_e/m_p = \varepsilon_m v_e$;

$$T_a = m_e v_e^2 + m_p v_p^2 = m_e v_e^2\left(1 + m_e/m_p\right) = m_e v_e^2\left(1+\varepsilon_m\right)$$

Configuration (**b**), where $m_e V_e = m_p V_p \Rightarrow V_p = m_e V_e/m_p = \varepsilon_m V_e$;

$$T_b = m_e V_e^2 + m_p V_p^2 = m_e V_e^2\left(1 + m_e/m_p\right) = m_e V_e^2\left(1+\varepsilon_m\right)$$

hence for $T_a = T_b$ we get $V_e = v_e$ and $V_p = v_p$. (As for $T_c = (T_a = T_b)$, next chapter).

Now, see Figure 8(b), r'_p can be found from the relation $v_e/r_B = v_p/r'_p$ yielding

$$r'_p = v_p r_B/v_e = \left(\frac{v_e m_e}{m_p}\right) r_B/v_e = r_B m_e/m_p = r_B\varepsilon_m \tag{49}$$

thus

$$r_0 = r_B + r'_p = r_B + r_B\varepsilon_m = r_B\left(1+\varepsilon_m\right) = r'_B\left(1+\varepsilon_m\right)/\left(1+\varepsilon_r\right) \tag{50}$$

Now, see Figure 8(c), equating along a *circular* orbit, the electron centrifugal force to the Coulomb one

$$m_r v_r^2 = e^2/4\pi\varepsilon_0 r, \tag{51}$$

and calling $U_{r\infty} = \int_r^\infty \left(e^2/4\pi\varepsilon_0 r^2\right)\mathrm{d}r$ the *necessary and sufficient* energy to move the electron charge from r toward ∞, and assuming $U_\infty = 0$, we get

$$U_{r\infty}\left(= -U_r\right) = e^2/4\pi\varepsilon_0 r \tag{52}$$

where $U_r = -e^2/4\pi\varepsilon_0 r$ is the potential due to electrostatic attraction. So the (51) becomes

$$m_r v_r^2 = U_{r\infty}\left(= -U_r\right) \tag{53}$$

Now, the *orbital* kinetic energy of m_r is $K_e = \frac{1}{2} m_r v_r^2$, thus, with W the related ionization energy, (that is the electron extraction work), we may write

$$U_{r\infty} = m_r v_r^2 = \frac{1}{2} m_r v_r^2 + \frac{1}{2} m_r v_r^2 \Rightarrow W\left(=K_e\right) = \frac{1}{2} m_r v_r^2 \tag{54}$$

The term $E = h\nu$, see (21), is the energy of light *passing along one ray*, thus, if the ionization energy $W\,(=\frac{1}{2} m_r v_r^2)$ is supplied by one ray of light (with energy $E = h\nu$) it must be

$$W\left(=E\right) \Rightarrow \frac{1}{2} m_r v_r^2 = h\nu \tag{55}$$

Therefore, substituting $2h\nu\,(=m_r v_r^2)$ into (51) and solving by r we get

$$r = e^2/4\pi\varepsilon_0 2h\nu = e^2/4\pi\varepsilon_0 m_r v_r^2 \tag{56}$$

Now, plugging into (56) the value of the highest H-atom spectrum frequency $\nu_0 = c/\lambda_0 = cR_H$ where R_H ($=1/\lambda_0$) is the Rydberg constant, whose experimental value is R_H = 10,967,758 m^{-1}, we get, as for H atom, see **Figure 8(c)**, the ground-state orbit (referred to the proton) of the reduced electron

$$r_0 = e^2/8\pi\varepsilon_0 h\nu_0 = e^2/8\pi\varepsilon_0 hR_H c = \alpha/4\pi R_H = 5.294654\times10^{-11}\ \text{m} \tag{57}$$

with $\alpha = e^2/2\varepsilon_0 hc$ the fine structure constant. Then writing the (50) as $r_B = r_0/\left(1+\varepsilon_m\right)$, we get

$$r_B = r_0/\left(1+m_e/m_p\right) = e^2/8\pi\varepsilon_0 hR_\infty c = \alpha/4\pi R_\infty = 5.291772\times10^{-11}\ \text{m} \tag{58}$$

corresponding to the Bohr radius, with $R_\infty = R_H\left(1+m_e/m_p\right)$, whereas, on our bases, r_B corresponds, see **Figure 8(b)**, to the ground-state orbit *of the electron* around the electron-proton centre of mass B.

Now, the speed of m_r along the orbit r_0, from (55),becomes

$$v_{r0} = \sqrt{2h\nu_0/m_r} = \sqrt{2hR_H c/m_r} = 2187691.2\ \text{m}\cdot\text{s}^{-1} \tag{59}$$

and given the frequency of the electron m_r along r_0 that is $\nu_{e0} = v_{r0}/2\pi r_0$, the ratio $2\nu_0/\nu_{e0}$, with r_0 ($=\alpha/4\pi R_H$) as given by (57), becomes

$$\begin{aligned} 2\nu_0/\nu_{e0} &= 2cR_H/\nu_{e0} = 2cR_H/\left(v_{r0}/2\pi r_0\right) = 2cR_H\Big/\sqrt{\left(2hR_H c/m_r\right)}\Big/2\pi r_0 \\ &= 2cR_H\Big/\sqrt{\left(2hR_H c/m_r\right)}\Big/\left(2\pi\alpha/4\pi R_H\right) = \alpha c\Big/\sqrt{2hR_H c/m_r} = 1.00000001 \end{aligned} \tag{60}$$

hence *it is consistent to assume* $2\nu_0/\nu_{e0} = 1$ (exactly). This ratio, written $2T_{e0} = T_0$, implies that, on H atom, *the light-electron impact time* T_0 *lasts for two electron orbits*.

Now, it is known that the admitted wavelengths, along circular orbits, have to satisfy the relation $\lambda_n = n^2\lambda_0$, with $n = 1, 2, 3, \cdots$ an integer, so we can also write

$$\nu_n = \nu_0/n^2\ \left(n = 1, 2, 3, \cdots\right) \tag{61}$$

with ν_n the *photons* admitted frequency along circular orbits. Then from (56) we can write

$$r_n = e^2/4\pi\varepsilon_0 2h\nu_n = e^2 n^2/4\pi\varepsilon_0 2h\nu_0 = r_0 n^2 \tag{62}$$

representing the radius of each circular orbit. Then, see (59), the orbital speed of the electron m_r along any circular orbit is

$$v_n = \sqrt{2h\nu_n/m_r} = \sqrt{2h\nu_0/n^2 m_r} = v_{r0}/n \tag{63}$$

while its frequency is

$$\nu_{en} = v_n / 2\pi r_n = v_{r0} / n2\pi r_0 n^2 = \nu_{e0} / n^3 . \tag{64}$$

Then, dividing (61) by (64) and because of the ratio $2\nu_o/\nu_{eo} = 1$, we get

$$\nu_n / \nu_{en} = (\nu_0 / \nu_{e0}) n \Rightarrow 2\nu_n / \nu_{en} = n \quad (n = 1, 2, 3, \cdots) \tag{65}$$

Now, as ν (= n/t) is the number n of *photons* passing along one ray during t, for $t = 2T_e$ one gets $\nu = n/2T_e = n\nu_e/2$, which equals the (65), so the integer n of (65) also represents the number of *photons* (of the same ray) absorbed (or emitted) by the electron during $2T_e$ and *this number, for all the n circular orbits of H atom, is an integer starting with* 1 *along the two orbits related to the photon* ν_0. [Between two circular orbits, the *photons* frequency are shown on Section 3.5].

The (65) written as $nT_n = 2T_{en}$ shows that the impact time nT_n of n *photons* (with frequency ν_n) equals the time needed by the electron, along the orbit r_n, for two orbits.

For $n = 1$, the Equation (65) corresponds to $2\nu_0 2\pi r_0/v_{r0} = 1$ and substituting here r_0 ($=e^2/8\pi\varepsilon_0 h\nu_0$), as given by (57), we get $4\pi\nu_0 e^2/8\pi\varepsilon_0 h\nu_0 v_{r0} = 1$, that is

$$4\pi\nu_0 e^2 / 8\pi\varepsilon_0 h\nu_0 = v_{r0} \Rightarrow v_{r0} = e^2 / 2\varepsilon_0 h = \alpha c = 2187691.2 \text{ m}\cdot\text{s}^{-1} \tag{66}$$

same value given by (59). Now, comparing (59) to (66) we find

$$\sqrt{2hR_H c/m_r} = \alpha c \Rightarrow R_H = \alpha^2 c^2 m_r / 2hc = 10967758 \text{ m}^{-1} \tag{67}$$

matching the R_H experimental value.

3.3. Impact *Photon*-Electron and Electron *Radial* Speed

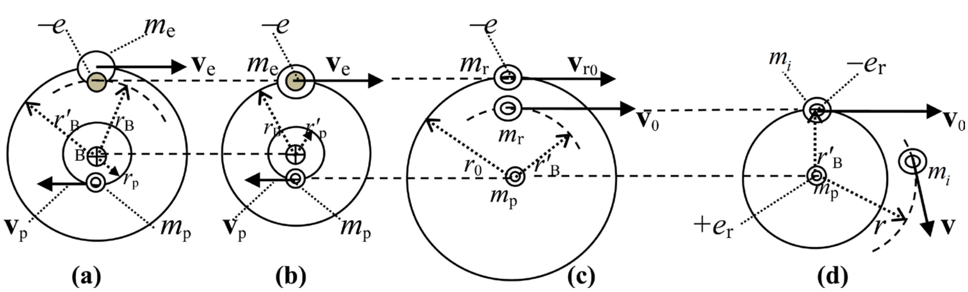

Figure 9. H atom configurations. (a) observed from the common centre of gravity B. (b) ditto, with the electron centre now coincident with its proper charge. (c) observed from the nucleus fixed as origin, with the reduced electron mass m_r. (d) observed from the nucleus, with m_i (here called *electron impact mass*) circling along the effective orbit r'_B, with two reduced charges ($-e_r$, $+e_r$).

Still referring to H atom, to apply properly the Conservation of momentum (CoM) to the impact photon-electron, we need, see **Figure 9**, a proper configuration where its nucleus should be fixed in the common centre of gravity B orbited by an equivalent electron mass m, as shown on **Figure 9(d)**.

The **Figure 9** shows the necessary passages, from **Figures 9(a)-(d)**, to obtain such a configuration.

Referring to **Figure 9(c)**, with m_r circling around r'_B, with orbital speed v_0, the (51) gives

$$m_{\mathrm{r}} v_0^2 r_{\mathrm{B}}' = e^2 / 4\pi\varepsilon_0 \tag{68}$$

and substituting, see (50), $r_{\mathrm{B}}' = r_0 (1+\varepsilon_{\mathrm{r}})/(1+\varepsilon_{\mathrm{m}})$, we can write

$$m_{\mathrm{r}} v_0^2 r_0 (1+\varepsilon_{\mathrm{r}})/(1+\varepsilon_{\mathrm{m}}) = e^2 / 4\pi\varepsilon_0 \tag{69}$$

then calling

$$m_{\mathrm{i}} \equiv m_{\mathrm{r}} (1+\varepsilon_{\mathrm{r}})/(1+\varepsilon_{\mathrm{m}}) \tag{70}$$

electron *impact mass*, we get

$$m_{\mathrm{i}} v_0^2 r_0 = e^2 / 4\pi\varepsilon_0 \tag{71}$$

and therefore

$$m_{\mathrm{i}} v_0^2 r_{\mathrm{B}}' = \left[(1+\varepsilon_{\mathrm{r}})/(1+\varepsilon_{\mathrm{m}})\right] e^2 / 4\pi\varepsilon_0 \tag{72}$$

we can now write

$$m_{\mathrm{i}} v_0^2 r' = e_{\mathrm{r}}^2 / 4\pi\varepsilon_0 \quad \text{where} \quad e_{\mathrm{r}} = e\sqrt{(1+\varepsilon_{\mathrm{r}})/(1+\varepsilon_{\mathrm{m}})} \tag{73}$$

showing, see **Figure 9(d)**, m circling along the orbit r_{B}', implying an electron/proton reduced charge e_{r}. Now, referring to **Figure 9(c)**, we have $m_{\mathrm{r}} v_{\mathrm{r0}}^2 r_0 = m_{\mathrm{r}} v_0^2 r_{\mathrm{B}}'$, and since, see (66), $v_{\mathrm{r0}} = \alpha c$, the orbital speed of m_{r} along the orbit r_{B}' becomes

$$v_0 = v_{\mathrm{r0}} \sqrt{(1+\varepsilon_{\mathrm{m}})/(1+\varepsilon_{\mathrm{r}})} = \alpha c \sqrt{(1+\varepsilon_{\mathrm{m}})/(1+\varepsilon_{\mathrm{r}})} \tag{74}$$

which, given ε_{m} and ε_{r}, leads to $v_0 = c/137$, as shown on next chapter.

We compare now the *total energy* T of the system electron-proton along the configurations of **Figure 9**: as for **Figure 9(a)** and **Figure 9(b)**, the total energy of the system is $T_{\mathrm{a}} = T_{\mathrm{b}} = m_{\mathrm{e}} v_{\mathrm{e}}^2 (1+\varepsilon_{\mathrm{m}})$; as for **Figure 9(c)**, along r_0, we get $T_{\mathrm{c}} = m_{\mathrm{r}} v_{\mathrm{r0}}^2 = m_{\mathrm{r}} \left(v_{\mathrm{e}} + v_{\mathrm{p}}\right)^2 = m_{\mathrm{r}} \left[v_{\mathrm{e}} (1+\varepsilon_{\mathrm{m}})\right]^2 = \left[m_{\mathrm{e}}/(1+\varepsilon_{\mathrm{m}})\right] v_{\mathrm{e}}^2 (1+\varepsilon_{\mathrm{m}})^2 = m_{\mathrm{e}} v_{\mathrm{e}}^2 (1+\varepsilon_{\mathrm{m}}) = T_{\mathrm{a}}$; on 6(**d**), $T_{\mathrm{d}} = m_{\mathrm{i}} v_0^2 = \left[m_{\mathrm{r}} (1+\varepsilon_{\mathrm{r}})/(1+\varepsilon_{\mathrm{m}})\right] v_{\mathrm{r0}}^2 \left[(1+\varepsilon_{\mathrm{m}})/(1+\varepsilon_{\mathrm{r}})\right] = m_{\mathrm{r}} v_{\mathrm{r0}}^2 = T_{\mathrm{c}}$.

The conservation of momentum, applied before and after an inelastic impact *photon*-electron, since *photon* and **w**, see **Figure 7**, have same direction, the (29), for a generic atom, gives

$$w = 2mc/m_{\mathrm{e}} = 2\gamma\nu c/m_{\mathrm{e}} = (2\gamma c/m_{\mathrm{e}})/T = 2\gamma\nu c^2/cm_{\mathrm{e}} = 2h\nu/cm_{\mathrm{e}} \tag{75}$$

representing the electron *radial* speed originated by an impact of **one** *photon* during the impact time T, while for n *photons* (with frequency ν) we have

$$w_n = nw = n2mc/m_{\mathrm{e}} = 2n\gamma\nu c/m_{\mathrm{e}} = 2nh\nu/cm_{\mathrm{e}} . \tag{76}$$

Regarding now the H atom and referring to **Figure 9(c)**, meaning to consider the electron reduced mass m_{r} circling along r_0, the (75) for $\nu = \nu_0$, becomes

$$w_0 = \frac{2h\nu_0}{cm_{\mathrm{r}}} = \sqrt{2h\nu_0/m_{\mathrm{r}}}\,\sqrt{2h\nu_0/m_{\mathrm{r}}}\,/c \tag{77}$$

and since, see (59), $v_{\mathrm{r0}} = \left(2h\nu_0/m_{\mathrm{r}}\right)^{1/2} = \alpha c$, as shown by (66), we get

$$w_0 = v_{\mathrm{r0}}^2/c = \alpha^2 c = 15964.35\ \mathrm{m\cdot s^{-1}} \tag{78}$$

while considering the configuration 9(**d**), where the electron m_i is circling along r'_B, we get

$$w_0 = 2h\nu_0/cm = \alpha^2 c(1+\varepsilon_m)/(1+\varepsilon_r) = 15{,}973.048\ \mathrm{m \cdot s^{-1}} \quad (\text{valid for } \varepsilon_r = r_e/r_B = 0) \quad (79)$$

close to $c/137^2$ = 15,972.743 m s^{-1}; on next chapter, via r_e, we get $w_0 = c/137^2$ and $v_0 = c/137$.

3.4. Ionization Condition, Number of Electron Circular Orbits (H Atom), and Electron Radii

Now, referring to **Figure 10**, let us consider an electron (m_e) circling, with velocity **v** around its nucleus with mass $m_N \gg m_e$, which can therefore be considered as fixed in the atom centre of gravity B; its removal may happen when its radial speed w equals v (=|**v**|) that is

$$w = v(\text{ionization condition}). \quad (80)$$

In particular, as for H atom, and referring to **Figure 9(c)**, let us consider the electron m_r circling along r_0; comparing (78), that is $w_0 = \alpha^2 c$, with (66) that is $v_{r0} = \alpha c$, we get $w_0/v_{r0} = \alpha \cong 1/137 \ll 1$.

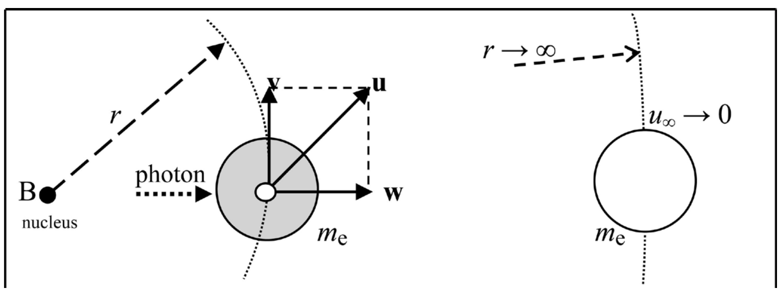

Figure 10. Ionization condition ($w = v$).

Now, along r_0, (ground-state orbit), we have $n = 1$ (meaning one *photon* along the double orbit r_0), hence the ionization, requiring $w_0/v_{r0} = 1$, cannot happen along r_0. Referring now to **Figure 9(d)**, along the ionization *double orbit* (in short d-orbit) # n_i, where the *photons* incident frequency, see (61), is $\nu_i = \nu_0/n_i^2$, the impact due to n_i-*photons* would produce, considering the electron impact mass m_i, an electron radial speed, see (76), equal to

$$w_{ni} = 2n_i h\nu_0/n_i^2 cm_i = 2h\nu_0/n_i cm_r(1+\varepsilon_r)/(1+\varepsilon_m) = w_0/n_i(1+\varepsilon_r)/(1+\varepsilon_m) \cong w_0/n_i \quad (81)$$

and since along this orbit (n_i), see (63), is $v_i = v_0/n_i$, where v_0 is given by Equation (74), we find

$$w_{ni}/v_i \cong (w_0/n_i)/(v_0/n_i) = w_0/v_0 = \alpha \cong 1/137 \ll 1 \quad (82)$$

hence the ionization, which requires $w_{ni} = v_i$, with only n_i *photons* along the n_i^{th}d-orbit, would never happen; thus we must infer that there are 137 progressive d-orbits, where the electron is circling n times along every d-orbit; thus the number of *photons* admitted along n d-orbits turns out to be n^2, yielding to the radial speed, along n ionization d-orbits n_i, the value $w_{n^2} = n_i w_{ni}$ which becomes

$$w_{n^2} = 2n_i^2 h\nu_0 / n_i^2 cm_i = 2h\nu_0 / cm_i = w_0 \quad (83)$$

giving the same radial speed w_o for any circular d-orbit, see Table 2.

Table 2. Ionization parameters of H atom (on the last column, 3rd line, change w_{n^2} according to the new value $2n^2\gamma c\nu_0 / n^2 m_i$).

Progressive number of each circular (double) orbit. n^{th}	Number of *photons* along each (double) orbit. n	Number of *photons* along n (double) orbits. n^2 -	***Photons*** frequency along the nth (double) orbit. $\nu_n = \nu_0 / n^2$ ($\times 10^{10}$ Hz)	Electron **orbital** speed along the n^{th} orbit. $v_n = v_0 / n$ m/s	Electron **radial** speed due to n^2 *photons* with frequency ν_n. $w_{n^2} = 2n^2\gamma c\nu_0 / n^2 m_i$ m/s
1st	1	1	328,805.1	2,188,266	15,972.74 (=w_0)
2nd	2	2^2	82,201.3	1,094,133	15,972.74
…	…	…	…	…	…
137th	137	137^2	17.52	**15,972.74**	**15,972.74** = $c/137^2$

Now we can obtain the radius (r_e) of the electron: indeed, along the ionization d-orbit n_i, the ionization condition $w_{n^2} = v_i$ becomes $w_0 = v_0/n_i$, and plugging v_0 as giving by (74) we get

$$n_i = v_0 / w_0 = \alpha c \sqrt{(1+\varepsilon_m)/(1+\varepsilon_r)} / w_0 \quad (84)$$

where w_0 is given by (77) and since $R_H \left(= 1/\lambda_0 = \nu_0 / c\right) = \alpha^2 cm_r / 2h$, see (67), we have

$$\begin{aligned} n_i &= \alpha c \sqrt{(1+\varepsilon_m)/(1+\varepsilon_r)} \Big/ \left(\frac{2h\nu_0}{cm_i}\right) = \alpha c^2 m_i \left[\sqrt{(1+\varepsilon_m)/(1+\varepsilon_r)}\right] \Big/ 2h\nu_0 \\ &= \alpha c^2 m_r \left[\sqrt{(1+\varepsilon_r)} \Big/ \sqrt{(1+\varepsilon_m)}\right] \Big/ 2hR_H c \\ &= \alpha c^2 m_r \left[\sqrt{(1+\varepsilon_r)} \Big/ \sqrt{(1+\varepsilon_m)}\right] \Big/ 2h\left(\alpha^2 cm_r / 2h\right) c \\ &= (1/\alpha)\left[\sqrt{(1+\varepsilon_r)} \Big/ \sqrt{(1+\varepsilon_m)}\right] = 136.99869 \quad (\text{valid for } \varepsilon_r = 0) \end{aligned} \quad (85)$$

but n_i has to be an integer so we can infer n_i = 137, giving

$$137^2 \alpha^2 (1+\varepsilon_m) = (1+\varepsilon_r) \Rightarrow \varepsilon_r = 137^2 \alpha^2 (1+\varepsilon_m) - 1 \quad (86)$$

yielding

$$r_e = r_B \left[137^2 \alpha^2 (1+\varepsilon_m) - 1\right] = (\alpha / 4\pi R_\infty)\left[137^2 \alpha^2 (1 + m_e/m_p) - 1\right] = 1.005172 \text{ fm} \quad (87)$$

Now, the correct values of m_i, w_o and v_o from (70), (79), (74), with ε_r given by (86), become

$$m_i = m_r (1+\varepsilon_r)/(1+\varepsilon_m) = m_r 137^2 \alpha^2 = 9.0996407 \times 10^{-31} \text{ kg}, \quad (88)$$

$$w_0 = \alpha^2 c (1+\varepsilon_m)/(1+\varepsilon_r) = c/137^2 = 15972.743 \text{ m}\cdot\text{s}^{-1}, \quad (89)$$

$$v_0 = \alpha c \sqrt{(1+\varepsilon_m)/(1+\varepsilon_r)} = c/137 = 2188266.1 \text{ m}\cdot\text{s}^{-1}. \quad (90)$$

Now, the (84), that is $n_i = v_0/w_0$, through (89) and (90) yields

$$n_i = v_0 / w_0 = (1/\alpha)\sqrt{(1+\varepsilon_m)/(1+\varepsilon_r)} = 137 \quad (91)$$

where n_i, on Absorption effect, is a specific constant representing the number of circular orbits as well as the numbers of admitted *photons* along theionization orbit.

3.5. Absorption/Emission Effect: *Photons* Admitted Frequencies, Claimed Fall of Circling Electron

Referring to Figure 11, where we represent the Absorption of *photons* from acircling electron, let us assume the nucleus mass $m_N \gg m_e$, so to consider the nucleus fixed in the atom centre of gravity B. Now, the expression of the total energy of the system *photon*-electron is given by

$$T = E + U_r + K_e + K_r \tag{92}$$

where $E(=mc^2)$ is the energy of the incident light, $U_r(=-e^2/4\pi\varepsilon_0 r)$ is the *potential* due to electrostatic attraction acting on the electron, $K_e(=\frac{1}{2}\ m_e v^2)$ is the electron *orbital* kinetic energy, and $K_r(=\frac{1}{2}\ m_e w^2)$ its *radial* kinetic energy (related to its radial speed w).

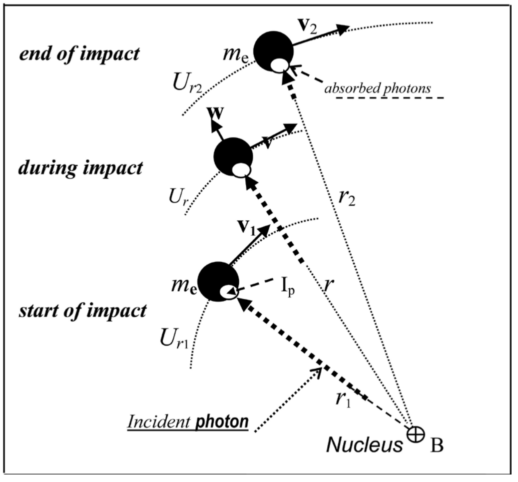

Figure 11. Absorption effect: Incident photons are absorbed by the electron which moves toward higher orbits; when re-emitted, (electron moving toward inner orbits), have contrary direction.

Regarding the Absorption/Emission effect (elements on gaseous form), see Figure 11, along circular orbits it is $K_r = 0$ and since, at the end of absorption, along the orbit r_2, (where the *photons* have been absorbed), it is $E_2 = 0$, *between two circular orbits* r_1 and r_2, the (92) gives

$$E_1 + U_{r1} + K_{e1} = U_{r2} + K_{e2}. \tag{93}$$

Now, from (53), $U_r = -m_e v^2$, and since $K_e = ½m_e v^2$, we get $\left(U_r + K_e\right) = -\frac{1}{2} m_e v^2$ so from (93) we have $E_1 - \frac{1}{2} m_e v_1^2 = -\frac{1}{2} m_e v_2^2$; thus, as $E_1 = h\nu$, and since $m_e v^2 = e^2/4\pi\varepsilon_0 r$ we find

$$h\nu = \frac{1}{2} m_e v_1^2 - \frac{1}{2} m_e v_2^2 = \left(e^2/8\pi\varepsilon_0\right)\left[\left(1/r_1\right) - \left(1/r_2\right)\right] \tag{94}$$

Then, according to (62) we have $r_1 = r_0 n^2$ and $r_2 = r_0 k^2$ (with $k > n$ as $r_2 > r_1$), thus

$$\nu = \left(e^2/8\pi\varepsilon_0 h r_0\right)_0 \left[\left(1/n^2\right) - \left(1/k^2\right)\right] \tag{95}$$

and plugging the (57) written as $\nu_0 = e^2/8\pi\varepsilon_0 h r_0$, we find

$$\nu = \nu_0\left[\left(1/n^2\right)-\left(1/k^2\right)\right] \tag{96}$$

which is the *photons* frequency between two circular orbits, where n, as showed on Section 3.2, is an integer representing the (progressive) number of each circular orbit, and where k turns out to have the values $k\left(=n+1, n+2, \cdots, n_{\mathrm{i}}\right)$ which is, one by one, the number of the *remaining* external circular orbits.

Claimed fall of a circling electron into its nucleus: an electrical current emits an electro-magnetic radiation and *therefore* it is claimed that the circulating electrical charge of an electron should also emit an e.m. radiation yielding the electron, in a short time, to fall into the nucleus; but on our results, a free electron, moving, for instance, along a copper wire under an electrical potential difference, when entering into an atom influence, (at that moment the electron charge will return to face the atom nucleus), will release the necessary *photons* to reach the atom energy level corresponding to the energy previously received (during the absorption effect). Indeed, along circular orbits, it is $w = 0$, therefore the absorption/emission of *photons* may only start/finish along these orbits, thus the circling electrons are absorbing/emitting *photons* only *between* circular orbits, so the e.m. radiation related to an electrical current is due to the emitted *photons* during their re-entry to an atom; by the way, *the photons emission is necessary for the electron not to fall into the nucleus.*

3.6. Photoelectric Effect: Number of *Photons* Necessary for the Atom Ionization

Between the electron ground-state orbit r_0 and its extraction orbit $r \to \infty$ (intending on microscopic scale), the (92), valid for *every* interaction light-matter, gives

$$E + U_{r0} + K_{\mathrm{e}0} + K_{r0} = E' + U_{r\to\infty} + K_{\mathrm{e}\infty} + K_{\mathrm{ae}} \tag{97}$$

with E' the energy of re-emitted light, w_{ae} the electron radial speed after its extraction, ($K_{\mathrm{ae}} = \frac{1}{2} m_{\mathrm{e}} w_{\mathrm{ae}}^2$ its kinetic energy), while the other terms have been defined referring to (92).

On ground-state, as also shown between Equations ((93) and (94)), it is

$$U_{r0} + K_{\mathrm{e}0} = -\frac{1}{2} m_{\mathrm{e}} v_0^2 \left(= -W_{\mathrm{f}}\right) \tag{98}$$

with v_0 the electron speed along r_0 and with W_{f} the Work function (electron extraction work); now, at the start of impact, $w = 0$ giving $K_{r0}\left(=\frac{1}{2} m_{\mathrm{e}} w^2\right) = 0$, while for $r \to \infty$, the electron orbital speed $v_\infty\, K_{r0}\left(=\frac{1}{2} m_{\mathrm{e}} w^2\right) = 0 \;\to 0$, so $\left(U_{r\to\infty} + K_{\mathrm{e}\infty}\right) = -\frac{1}{2} m_{\mathrm{e}} v_\infty^2 \to 0$, and (97) gives

$$E - W_{\mathrm{f}} = E' + K_{\mathrm{ae}} \Rightarrow E = E' + W_{\mathrm{f}} + K_{\mathrm{ae}} \Rightarrow E = E' + K = E' + \frac{1}{2} m_{\mathrm{e}} w^2 \tag{99}$$

where $W_{\mathrm{f}} + K_{\mathrm{ae}} \equiv K = \frac{1}{2} m_{\mathrm{e}} w^2$ is the total kinetic energy transferred from light to electron. On Photoelectric Effect (PhE), the light scatters off an electron ($K_{\mathrm{ae}} \geq 0$), but it is not re-emitted, ($E' = 0$), so the (99), with ν_{f} ($= W_{\mathrm{f}}/h$) the specific threshold frequency, becomes

$$E = W_f + K_{ae} = K = \frac{1}{2} m_e w^2 \Rightarrow h\nu = h_f \nu_f + \frac{1}{2} m_e w_{ae}^2 = \frac{1}{2} m_e w^2 \tag{100}$$

showing that for $\nu = \nu_f$ there is ionization with $w_{ae} = 0$.

At frequency ν_f the electron radial speed w_f, due to the impact of one *photon*, see Equation (75), is $w_f = 2h\nu_f / m_e c = 2W_f / m_e c$, and writing the (55) as $v_0 = (2W_f/m_e)^{1/2}$, we get

$$w_f / v_0 = \left(2W_f / m_e c\right) \Big/ \sqrt{2W_f / m_e} = \sqrt{2W_f / m_e} \Big/ c = v_0 / c \Rightarrow w_f = v_0^2 / c \tag{101}$$

and since the values of W_f are in the range 2 - 6 eV, the (101) gives $w_f/v_0 \cong 0.0028$ - 0.0048 meaning that the ionization, requiring $w = v_0$, at frequency ν_f needs n_f *photons*, as follows: the electron radial speed due to n_f *photons* with frequency ν_f, see (76), is $w_{nf} = n_f w_f = n_f 2W_f / m_e c$, so the ionization condition ($w = v$) becomes $w_{nf} = v_o$ leading to $n_f 2W_f / m_e c = \left(2W_f / m_e\right)^{1/2}$ giving

$$n_f = c\sqrt{m_e / 2W_f} = c / v_0 = v_0 / w_f \tag{102}$$

that is, on PhE, the number of *photons* at frequency ν_f *necessary* for ionization($w_{ae} = 0$). Now, if n_f *photons*, at frequency ν_f, are sufficient for ionization, then the frequency

$$n_f \nu_f \equiv \nu_1 \tag{103}$$

is sufficient for ionization ($w_{ae} = 0$) with one *photon* only, meaning that ν_1 is the threshold between PhE and Compton effect which requires one *photon* only, as shown on next chapter.

Now let us find the number n_1 (giving $w_{ae\,max}$) of the impacting *photons* at frequency ν_1: writing the (100) as $h\nu = 1/2 m_e w^2$, (energy transferred from a ray of light to an electron), one gets $w = (2h\nu/m_e)^{1/2}$ which has to be equal to the electron radial speed due to n *photons*, $w_n = 2nh\nu/cm_e$, see (76); so, for $\nu = \nu_1$ and $n = n_1$, we get $\left(2h\nu_1 / m_e\right)^{1/2} = 2n_1 h\nu_1 / cm_e$ yielding

$$n_1^2 = m_e c^2 / 2h\nu_1 = m_e c^2 / 2hn_f \nu_f = m_e c^2 / 2n_f W_f \Rightarrow n_1 = c\sqrt{m_e / 2n_f W_f} \tag{104}$$

with n_1 the number of impacting *photons* at frequency ν_1 and plugging n_f given by (102), we find

$$n_1 = \sqrt{n_f} \tag{105}$$

meaning that on PhE, the number of impacts *photons*-electron varies from n_f related to the frequency ν_f to $n_1 \left(= n_f^{1/2}\right)$ related to the max admitted frequency ν_1 ($= \nu_f n_f$). For instance as for caesium (Cs), having $W_f \cong 2$ eV, since $n_f = c\left(m_e / 2W_f\right)^{1/2} \cong 357$, we may infer $n_f = 361$ leading to $n_1 = 19$, while as for Pt, having $W_f \cong 6$ eV, we may infer $n_f = 196$ leading to $n_1 = 14$.

3.7. Compton Effect: Number of *Photons* Involved and Compton Equation via Doppler Effect

Here, see Figure 12, the incident *photon* (length λ, frequency ν), while ejecting a circling electron is also reflected (λ', ν') so the recoiling electron, emitting a *photon* λ' toward the Observer A, represents a source in motion from A along the direction **w**, implying an *undoubted* Doppler effect.

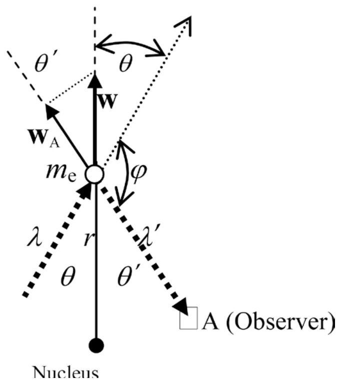

Figure 12. Compton effect (CE). φ: angle between the direction of the incident *photon* and the scattered one (λ'); θ: angle between the direction of the incident *photon* λ and the recoiled electron; $\theta'(= \pi - \varphi - \theta)$: it will be shown that $\theta' = \theta$.

Now, on the basis that the scattered *photon* starts to be reflected at the same time when the incident *photon* starts to hit the electron, and since $T'(=1/\nu')$ is the emission time of the reflected *photon*, it turns out that T' is also the whole interaction time, meaning that there is not a complete absorption of the incident *photon* followed by an emission. Now, with T' the whole impact time *photon*-electron, the momentum transferred from the *incident* light to the electron, as per (30), is $p(=m'c = \gamma\nu'c = \gamma c/T')$ and the same value is then transferred from the reflected *photon* to the electron, so the Conservation of Momentum (CoM) along the direction normal to **w**, becomes

$$\gamma c/T' \sin\theta = \gamma c/T \sin\theta' \tag{106}$$

giving $\theta = \theta'$. Then, the length of the reflected *photon*, for the Observer A, see Equation (12) is

$$\lambda' = \lambda + \Delta\lambda \tag{107}$$

where $\Delta\lambda = w_A T'$ and where $w_A = w\cos\theta$ is the component of the electron speed along the direction of the Observer A and $T'(=1/\nu')$ is, for A, the *photon* transit time, so we get

$$\lambda' - \lambda(\equiv \Delta\lambda) = wT'\cos\theta \tag{108}$$

Now the CoM along **w** is

$$(\gamma c/T'\cos\theta) + (\gamma c/T'\cos\theta) = m_e w \tag{109}$$

giving

$$wT' = (2\gamma c\cos\theta)/m_e \, . \tag{110}$$

Then, plugging this value into (108) we get

$$\lambda' - \lambda(\equiv \Delta\lambda) = (2\gamma c\cos^2\theta)/m_e = (2h\cos^2\theta)/cm_e \tag{111}$$

Now, $2\theta + \varphi = \pi$, $\Rightarrow \theta = (\pi - \varphi)/2$, hence $\cos\theta = \sin\varphi/2$ and therefore

$$\Delta\lambda = 2h\sin^2\left(\frac{\varphi}{2}\right)\Big/cm_e \tag{112}$$

and since $2\sin^2\frac{\varphi}{2} = (1-\cos\varphi)$, *we get the Compton equation*:

$$\Delta\lambda = \lambda' - \lambda = h(1-\cos\varphi)/cm_e \tag{113}$$

which cannot be obtained via the Doppler effect relativistic equations regarding the light.

Then, the (110), for $\cos\theta = 1$, equals the (75), implying the impact of **one** *photon* only.

Now, the (111), for $\cos\theta = 1$ gives $\lambda' = (c/\nu) + 2\gamma c/m_e$, or $T' = (1/\nu) + 2\gamma/m_e = (m_e + 2\gamma\nu)/\nu m_e$ which plugged into (110) gives

$$w = (2\gamma c/m_e)/(m_e + 2\gamma\nu)/\nu m_e = 2\gamma\nu c/(m_e + 2\gamma\nu) = c/(1 + m_e/2\gamma\nu) \tag{114}$$

yielding, see **Figure 13**, $w \to c$ for $\nu \to \infty$, whereas, for inelastic impacts, w is proportional to ν.

Then, as for the electron radial speed after its extraction, here indicated v, from (100) we have $W_f + K_{ae} = 1/2 m_e w^2$ where $K_{ae} = 1/2 m_e v^2$ and since $W_f = \frac{1}{2} m_{ee} v_0^2$ as shown by (98), we get

$$\frac{1}{2} m_e v_0^2 + \frac{1}{2} m_e v^2 = \frac{1}{2} m_e w^2 \Rightarrow v = \sqrt{w^2 - v_0^2} \tag{115}$$

which for $w = v_0$, (ionization condition) gives $v = 0$, as represented on the Figure.

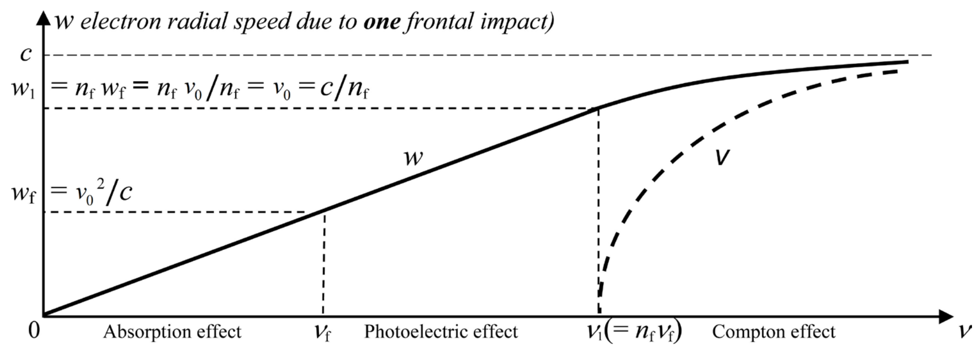

Figure 13. Relation between the incident frequency ν and the electron radial speed (w) due to one *photon*.

4. Conclusions

The Relativity arose as a result of attempts to explain the (apparent) constancy of the speed of light which was supported by many experiments: in fact, on our bases/results, there is, on Earth, a continuous variation of c_o (c on Earth) which, from Equation (8), can be written $\Delta c = -\Delta U/c_o$ with ΔU the variation of the total potential on Earth (mainly due to the variable distance (d) Earth-Sun); indeed, between Aphelion and Perihelion ($\Delta d_{PA} \cong 5 \times 10^9$ m), we get $\Delta c_{PA} = -\Delta U/c_o = -M_S G \Delta d_{PA}/d^2 c_o \cong -0.1\ \mathrm{m \cdot s^{-1}}$ well lower than the accuracy of the measured value of c_o. Anyhow, under the assumption that the light is composed of longitudinal-extended elastic and massive particles (*photons*) emitted at a speed equal to the *total* escape speed, we showed that the speed of light, under a constant *total* potential, is constant for every Observer, in accordance with the Newtonian laws.

Moreover, the Relativity Theory may last until a contrary experiment: well, an update experiment, similar to the Harvard tower experiment, would show that the direction of the *compensating velocity*, (between the source and the absorber), is contrary, as per our results, to the one predicted by the Relativity.

The Quantum Mechanics arose as a result of attempts to explain the discrete spectrum of the hydrogen atom: here, a revised electron structure, an H atom new configuration, and the introduction of *these photons* for the interaction light-matter, gave a *Newtonian* answer to that question.

On the **Appendix**, we have described, in short, the main differences between the Relativity and our results, as well as between QM and our results.

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[5] Nasa Extragalactic Database: (*i.e.* Galaxy M86 Has $z \cong -0.001$ with $s \cong 16$ Mpc; M99 Has $z \cong +0.008$ with $s \cong 15$ Mpc; NGC0063 Has $z \cong +0.004$ with $s \cong 20$ Mpc; VCC0815 Has $z \cong -0.0025$ with $s \cong 20$ Mpc).

Appendix

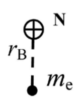
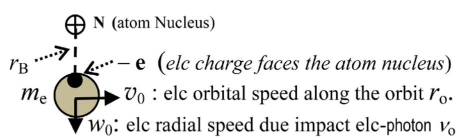
Comparison sheet, (short summary), between the Relativity Theory and our results.

Abbreviations: S = source (of light); ν = freq. of light stated by S; O = Observer; ν_O = freq. stated by O; U = *total*-grav. potential.

Subject	According to Relativity	Our results
Composition of the light	wave/ massless point-particle	longitudinal-extended elastic particle (photon).
Frequency of the light	number of waves in 1 s	number of photons, same ray, crossing O in 1s.
Wavelength	distance between two wave peaks	length of one photon.
Reason of the value of c	*unknown*	*Escape speed from all the masses*: $c = (-2U)^{1/2}$.
Value of c	constant	constant if U is constant; $c \to 0$ for $U \to 0$.
Longitud. Doppler effect	$\nu_O = \nu(1\pm\beta)/(1\pm\beta^2)^{1/2}$	$\nu_O = \nu/(1\pm\beta)$
Transverse Doppler effect	$\nu_O = \nu(1\pm\beta^2)^{1/2}$	$\nu_O = \nu/(1\pm\beta^2)^{1/2}$
S on the ground emits upwards	O in altitude (h) states a red shift	O in altitude (h) observes a blue shift.
S in altitude emitting downwards	O on the ground states a blue shift	O on the ground states a red shift.
S taken from ground to altitude h	at height h, $c_h = c_0, \nu_h = \nu_0, \lambda_h = \lambda_0$	$\lvert U_h\rvert < \lvert U_0\rvert \Rightarrow c_h < c_0;\ \nu_h < \nu_0;\ \lambda_h = \lambda_0$.
Atomic clocks on GPS satellites	time dilation $\Delta t = 38.4$ μs/day	same value, but due to variation of ν_h.
Cosmological high red shift (light from far sources to the Earth)	due to Doppler effect, implying the universe expansion	due to increase of c (and λ too) along the path source-Earth where $\lvert U_E\rvert >> \lvert U_S\rvert$.

between QM and our results

Abbreviations: **elc**: electron; **gso**: ground state orbit; ν_e: elc freq.; m_r: elc reduced mass; m_p: proton mass; **N**: atom nucleus; **on H atom**: r_o: gso of m_r ref. to **N**; ν_{eo}: freq. of m_r along r_o; ν_{eB}: freq. of m_r along r_B; ν_o: photon freq. along r_o.

Subject	According to QM	Our results
Structure of electron	assumed as a point-particle	as shown hererafter
as for the H atom:		
Bohr radius, r_B	gso of electron (and charge)	r_B: gso of elc charge.
$2\nu_0/\nu_e$	$2\nu_0/\nu_{eB} = 2R_Hc/\nu_{eB} = 1.00027$	$2\nu_0/\nu_{e0} = 2R_Hc/\nu_{e0} = \alpha(cm_r/2hR_H)^{1/2} = 1$ (**exact**).
n: quantum numbers	$n = 1 \to \infty$	$n = 1, 2, \ldots 137$ elc circular orbits.
Meaning of n	related to the H atom energy level	number of photons (same ray) absorbed/emitted during 2 elc circular orbits.
r_e : elc radius	$=\alpha^2 r_B \cong 2.82$ fm (known as *classical* value)	$r_e = r_B[\alpha^2 137^2(1+m_e/m_p)-1] \cong 1.005$ fm
m_i: *elc impact mass* (new term)	*not predicted*	$m_i \equiv m_r(1+r_e/r_B)/(1+m_e/m_p)$.
elc ***radial speed*** due to photon ν_o	*not predicted*	$w_o = 2h\nu_o/cm_i = c/137^2$.
elc ***orbital speed*** *along its gso*	$v_0 = (e^2/4\pi\varepsilon_0 m_e r_B)^{1/2} = \alpha c$	$v_0 = \alpha c[(1+m_e/m_p)/(1+r_e/r_B)]^{1/2} = c/137$
r_i : elc *ionization* orbit	r_i = *not defined*	$r_i = 137^2 r_o$
Photoel effect: num of photons at ν_f, with $\nu_f = W_f/h$, the threshold freq.	*not predicted*	$n_\gamma = c(m_e/2W_f)^{1/2}$ necessary for ionization
Compton effect, photons required	$n_\gamma = 1$ (ray)	$n_\gamma = 1$ photon, length λ
Photons emitted by a source, power P	$n_\gamma = P/h\nu$ photons/s (on our results, it is the number of rays/s)	$n_\gamma = P/h$ photons (emitted in 1 s), all the rays

Symbols

E (= mc^2) energy of the light flowing along one ray,

m = mass of light passing along one ray in 1s,

ν = *photons* frequency (number of *photons* of the same ray, crossing an Observer, in 1s),

T = *photon transit time* (time for one *photon* to cross an Observer),

γ (= mT) mass of light passing along one ray during T,

ν_0 = *photon* admitted frequency along the electron ground-state orbit, on H atom

ν_n = *photon* admitted frequency along the nth circular electron orbit on H atom,

ν_f (= W_f/h): specific threshold frequency on Photoelectric effect (PhE),

ν_1 = max admitted frequency on PhE; also minimum frequency able to produce the Compton effect,

$\varepsilon_m \equiv m_e/m_P$ (where m_e= electron mass and m_p = proton mass),

r_0 = ground-state electron orbit on H atom: orbit of m_r referred to m_p (see **Figure 8**),

r_B = Bohr radius: electron charge orbit, referred to common centre of gravity (CCG) electron-proton,

r'_B = *adjusted* Bohr radius: electron centre of mass referred to the CCG electron-proton,

$\varepsilon_r \equiv r_e/r_B$ (where r_e = electron radius),

ν_e = electron frequency,

ν_{e0} = electron frequency on ground-state orbit r_0, H atom,

ν_{en} = electron frequency along the nth orbit, H atom,

v = generic speed, also electron orbital speed,

w = electron radial speed, due to the impact of one photon, referred to the atom centre of gravity,

w_0 = electron radial speed due to the impact of one photon with frequency ν_0,

w_f = electron radial speed due to the impact of one photon with frequency ν_f,

w_n = electron radial speed due to the impact of n photons,

w_{n0} = electron radial speed due to the impact of n photons with frequency ν_0,

n_i = number of admitted *photons* along the ionization orbit,

w_{ni} = electron radial speed due to the impact of n photons with frequency ν_0/n_i^2,

w_{n^2} = electron radial speed due to the impact of n^2 photons,

K_r (= $\frac{1}{2}m_e w^2$) = electron radial kinetic energy,

w_{ae} = electron radial speed after extraction (on macroscopic scale), on photoelectric effect (PhE),

K_{ae} = electron radial kinetic energy after extraction (on macroscopic scale), on PhE,

V = electron radial speed after extraction (on macroscopic scale), on Compton effect.