

Three Conditions Leading to a Unified (Quasi-Newtonian) Physics

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Abstract

It is shown that the *total* escape speed u (*i.e.* from all the masses in space), which depends on the *total* gravitational potential U through the relation $u = (-2U)^{1/2}$, tends to c ; then, under the 1st condition $c = u$, and assuming (as a 2nd condition) the light as composed of longitudinally-extended, elastic (*i.e.* variable length) and massive particles, (photons), emitted at speed u referred to the *initial* location (O) of their source, we show that c referred to O becomes invariant despite any motion of its source from O. We revised the Doppler effect for the light, the gravitational redshift cause, the time dilation, highlighting the differences with respect to the Relativity. In the 2nd part, considering (3rd condition) the electron charge as a point-particle fixed to the electron surface and facing the atom nucleus during the electron orbit, the light-matter interaction becomes a consequence of the *particular* impacts between these photons and the circling electrons: e.g., 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* physics, under the assumption that a circling electron should produce (like a macroscopic electric circuit), an electro-magnetic radiation, implies that this *claimed* effect has to cause the electron fall into its nucleus: on Section 2.5, we show that the e.m. radiation of a circling electron only happens *between* two circular orbits].

Keywords

Doppler Effect for the Light, Harvard Tower Experiment, Gravitational Redshift, Time Dilation, Absorption/Emission, Photoelectric and Compton Effects

1. Speed of Light

1.1. Introduction

This paper is based on the following assumptions:

- 1) Finite mass of the universe.
- 2) Newton's absolute time and space.

Then, the following two conditions:

- Equality between the speed of light c and the *total* escape speed u .
- Light composed of longitudinal-extended, elastic particles, as defined on Section 1.4.

We obtain, on the 1st Part, these main results:

1) The measured constancy of c is due, first, to the constancy of the *total* gravitational potential U on Earth: indeed, the max variation of U on Earth, occurring between Aphelion and Perihelion, leads to a negligible $\Delta u_{AP} = 0.10 \text{ m}\cdot\text{s}^{-1}$; moreover, the speed of light emitted by a source, either fixed or in motion from its *initial* location O (where the photons emission starts), is invariant with respect to O ;

2) Doppler effect equations for the light, slightly different from the relativistic ones;

3) The *compensating velocity*, (to restore the resonance source-absorber on Harvard Tower Experiment), has same value but contrary direction with respect to the one predicted by GR;

4) The variation of U from ground to GPS satellite level, implying a decrease of c and consequently a decrease of the frequency of the photons emitted by atomic clocks at that altitude, give them an increase of their counted time (inducing them to run faster);

5) High gravitational redshifts are due to the increase of c (inducing the increase of the photons length λ) during their path toward the Earth where $|U_0| \gg |U_{\rightarrow\infty}|$.

On the 2nd part, under the third condition claiming that the electron charge can be considered as a point-particle fixed to the electron surface, and facing the atom nucleus during the electron orbit, we got these results:

On H atom:

6) $n = 1, 2, \dots, 137$ electron circular progressive orbits, not an infinite number; n also represents the number of admitted photons (of the same ray) absorbed (or emitted) by the electron during two electron orbits: (in fact, the photons total number along each circular double-orbit (in short d-orbit) becomes n^2 , as shown on Section 2.4);

7) The electron radius becomes $r_e = [(1/137\alpha) - 1]r_0$ (instead of its *classical* value $r_e = \alpha^2 r_B$ with $r_B = \alpha/4\pi R_\infty$ the Bohr radius and α the fine structure constant); $r_0 = \alpha/4\pi R_H$ is the orbit of the electron charge, while the orbit of the electron barycenter (electron *effective* orbit) becomes $r'_0 = r_0 + r_e = r_0/137\alpha$;

8) The electron charge orbital speed along r_0 becomes $v_0 = \alpha c$, while the electron *effective* orbital speed along the orbit r'_0 becomes $v'_0 = c/137$;

9) The electron *radial* speed (due to the impacts *photons*-electron) becomes $w_{n^2} = c/137^2$ constant for every circular orbit; along the orbit #137, the electron orbital speed becomes $v_{137} = c/137^2$ and since $w_{n^2} = v_{137}$ there is ionization.

10) On Photoelectric effect the number of *photons* hitting a circling electron varies from n_f related to the specific threshold frequency $\nu_f (= W_f/h)$ to $(n_f)^{1/2}$ related to a higher frequency corresponding to the lower frequency occurring for the Compton effect; for instance, it is shown that, as for Caesium (having $W_f \cong 2$ eV), $n_f = 361$;

11) Compton effect (CE) needs one *photon* only; our Doppler effect equations for the light lead to Compton Eq., while, as for the Relativity, the CE is not a Doppler effect.

1.2. Total Escape Speed u and Evidences That $u = c$

As known, considering in space only one mass M , (for simplicity its barycenter), the gravitational potential U in a point O, assuming $U_\infty = 0$, is $U = -MG/s$, with s the distance M -O. The conservation of energy applied to a particle m (of unitary mass) coming from the infinity, gives $E = U + K$, with $K = \frac{1}{2}u^2$ its kinetic energy, therefore for $E = 0$, one finds $U = -K$, yielding

$$u = \sqrt{-2U} = \sqrt{2MG/s} \quad (1)$$

which is a scalar, (called *escape speed*), representing the value of the velocity \mathbf{u} , (referred to M), a massive particle needs to reach the infinity; hence the relation

$$\mathbf{v}_{Mm} = \mathbf{u} \quad [\text{with } |\mathbf{u}| = u = (-2U)^{1/2}] \quad (2)$$

represents the condition, as for a point-particle m , to be provided with the *absolute* escape velocity \mathbf{u} (*absolute* means here referred to M) whereas considering a generic point O,

$$\mathbf{v}_{Om} \equiv \mathbf{u}_O \quad [\text{with } |\mathbf{u}_O| = u_O = (-2U_O)^{1/2}] \quad (3)$$

represents the condition, regarding m , to be provided with the *relative* escape velocity \mathbf{u}_O , where *relative* means here referred to a generic point O; (anyhow, our *claimed* variable length of photons, during their emission from a source S gives them an invariant speed referred to any considered point O, in spite of any velocity \mathbf{v}_{OS}).

Regarding the possibility to define the escape speed from two or more masses, ***we point out that considering M as a real mass, the potential U , in a considered point, has to be regarded as the sum of the partial potentials U_n due to each partial mass M_n composing the mass M*** ; therefore, as for two masses, we have

$$U_{1,2} \equiv U_1 + U_2 = -(M_1G/s_1) - (M_2G/s_2) \quad (4)$$

yielding $u_{1,2} \equiv \sqrt{-2U_{1,2}} = \sqrt{-2(U_1 + U_2)}$ thus we can write

$$u_{1,2}^2 = -2U_{1,2} = u_1^2 + u_2^2 \quad (5)$$

while for all the n masses in space we get

$$u \equiv (-2U)^{1/2} = (-2\Sigma U_n)^{1/2} = (2\Sigma M_n G/s_n)^{1/2} = \sqrt{\Sigma u_n^2} \quad (6)$$

representing the *total* escape speed.

For instance, the escape speed from the Earth surface, due to Earth and Sun only, becomes $u_{E,S}^2 = u_E^2 + u_S^2 = (2M_E G/R_E) + (2M_S G/d)$ with R_E the Earth ra-

dus, and d the distance Earth-Sun giving $u_{e,s} \cong 42$ km/s, while the escape speed from our Galaxy can be *roughly* expressed as $u_g \cong (2M_g G/d_g)^{1/2}$ where $M_g \cong 10^{42}$ kg is our Galaxy mass and $d_g \cong 30$ kly $\cong 3 \times 10^{20}$ m the distance between the Earth and our Galaxy centre, giving $u_g \cong 8 \times 10^5$ m·s⁻¹.

Now, the mass of universe, by some authors, is estimated [1] [2] [3] to be $M_u \cong 10^{53}$ kg; about the same value is given through the number ($\cong 10^{22}$) of observable stars [4] [5] [6], and since from Earth the distribution of the masses appears to be homogeneous and isotropic, under our assumption $U_\infty = 0$, we may assume their density as decreasing toward the infinity like a function $\rho = \rho_c e^{-as}$ being $\rho_c \cong 9.2 \times 10^{-27}$ kg/m³ the *critical density*.

Writing the mass of universe as

$$M_u = \int_0^\infty 4\pi s^2 \rho_c e^{-as} ds = 4\pi \rho_c \int_0^\infty s^2 e^{-as} ds = \frac{8\pi \rho_c}{a^3} \cong 10^{53} \text{ kg} \quad (7)$$

we find

$$a = (8\pi \rho_c / M_u)^{1/3} \cong 1.3 \times 10^{-26} \text{ m}^{-1} \quad (8)$$

and since, on Earth, the variation of potential due to an increase of the distance ds , can be written $dU = -dm G/s$ with $dm = \rho 4\pi s^2 ds$ and $\rho = \rho_c e^{-as}$, the potential on Earth becomes

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

yielding

$$u_0 = (-2U_0)^{1/2} \cong (9 \times 10^{16})^{1/2} \cong 3 \times 10^8 \text{ m/s.} \quad (10)$$

We can therefore infer that, on Earth, $u_0 = c_0$, giving $c_0^2/2 = -U_0$ and, in general,

$$c = (-2U)^{1/2} = u. \quad (11)$$

The equality $c = u$, which implies the massiveness of light, means that, along any free path, the speed of light only depends on the value of the potential along that path.

The equality $c = u$ is also supported by a cosmological reason: in fact, if $c > u$ the energy of light will be lost forever and furthermore the *observable* masses, following the always increasing mass of light going toward the infinity, will also tend to the infinity moving away from each other. On the contrary, if $c < u$, all the masses in space, (having speed lower than u), will tend to a gravitational collapse, whereas for $c = u$, the mass of light, tending to the infinity in an unlimited time, appears to be the necessary mass to avoid the two events (collapse or dispersion).

1.3. Annual Variation, on Earth, of the Total Escape Speed

On Earth, a small variation of the total escape speed u_0 , from Equation (11) written as $u^2 = -2U$ yielding $2u = -2dU/du$, can be written as

$$\Delta u = -\Delta U/u_0 \quad (12)$$

where ΔU is the variation of the *total* potential on Earth, mainly due to the variable distance Earth-Sun; so, between Aphelion and Perihelion, where $a = (1 + e)d$ and $p = (1 - e)d$ are the respective distances Earth-Sun, with $e (=0.0167)$ the eccentricity of the Earth's orbit and $d \cong 1.5 \times 10^{11}$ m the average distance Earth-Sun, and since $pa \cong d^2$, and $(a - p) = 2ed$, we get

$$\begin{aligned} \Delta u_{AP} &= -\Delta U_{AP}/u_0 = -(U_p - U_A)/u_0 = [(M_S G/p) - (M_S G/a)]/u_0 \\ &\cong M_S G(a - p)/d^2 u_0 \cong M_S G 2ed/d^2 u_0 \cong M_S G e/du_0 \cong +0.10 \text{ m s}^{-1} \end{aligned} \quad (13)$$

with $M_S = 2 \times 10^{30}$ kg the mass of the Sun, and we note that Δu_{AP} is compatible with the accuracy of the value of the speed of light in vacuum (on Earth) $c_0 = 299,792,458 \text{ m}\cdot\text{s}^{-1}$.

1.4. Definition of Photons and Their Speed

The Galileo's velocity composition law (since different parts of a moving object may have different velocity) is strictly valid for point-particles, and therefore the light cannot be a succession of point-particles (otherwise it should follow this Galileo's law), hence we may infer that the light, to comply both this law and the equality $c = u$, could be composed of particular particles, photons, (whose physical characteristics are then shown on §2.2), as defined:

Longitudinally-extended, elastic (variable length) and massive particles emitted by a source during an *emission time* T at speed $c = u$ moving individually or along rays, (continuous succession of photons where every *tail* corresponds to the *front* of the next one).

Photons speed: the measurement of the speed of a point-particle (or regarding an object, its barycentre), is defined through the ratio $v = d/t$ with d the distance between **two Observers** (O_1 and O_2) and $t (=t_2 - t_1)$ the time the particle/barycentre needs to cover such a distance; on the contrary, every photon may have different length with respect to two Observers, (like, for instance, an elastic thread during its stretching), hence to define the speed of *one* photon, we must consider its length λ divided its *transit time* T_t (time the whole particle needs to cross **one Observer**). Therefore the relation

$$c = \lambda/T_t \quad (14)$$

represents the speed of *one* photon referred to a considered Observer, whereas the relation $c = d/t$, written as

$$c = d/t = n\lambda/nT_t = \lambda/T_t \quad (14\text{-a})$$

where n is the number of photons (of one ray) each of them having length λ , and where $t = nT_t$ is the transit time of the n photons, represents the *average* speed of the light along d .

1.5. Invariance of c for Observers at Rest with Respect to the Initial Location O of a Source of Light, Despite Any Velocity v_{0S}

Referring to **Figure 1**, let O be the location (with respect to all the masses in

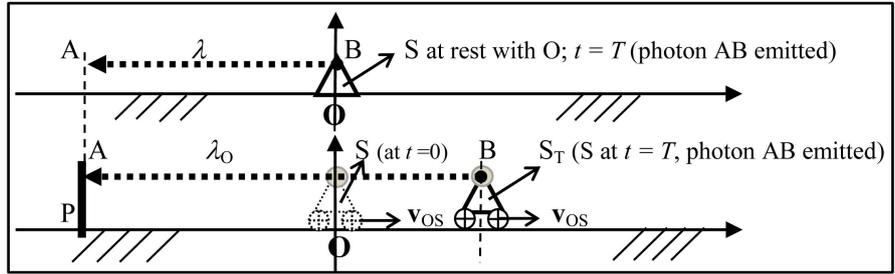


Figure 1. Emission of the photon AB by a source S either at rest or in motion from O.

space) of the source S at the time ($t = 0$) the *front* A is emitted; therefore O represents the location of the *initial* emission of a considered photon.

The Earth’s surface, where c_0 is practically constant, has to be intended as the basic reference frame for the parameters of light (λ, ν) while other frames, because of the Doppler effect, would give, for the same source, different values. So, still referring to **Figure 1**, we intend the frame O as fixed to the Earth’s surface. We also intend:

T : emission time of the considered photon AB.

λ : length of the emitting photon if S is fixed to O during T .

λ_0 : length of an emitting photon if S during T is in motion with respect to O.

T_t : transit time of one photon (T_0 for O, T_p for P, while $T_s = T$).

On **Figure 1**, if S during T is fixed to O, the speed of the front A (considered as a point-particle), see Equation (3), is $v_{OA} = u_0$, where u_0 only depends on the location of O, thus, at $t = T$, the length λ of the photon AB corresponds to the path covered by A, so we have

$$v_{OA}T = u_0T \equiv (= v_{SA}T \text{ for S fixed to O during } T). \tag{15}$$

If S has velocity \mathbf{v}_{OS} with respect to O, the velocity of the front A, referred to S, being $\mathbf{v}_{SA} = \mathbf{v}_{SO} + \mathbf{v}_{OA}$ and since from (3), $\mathbf{v}_{OA} = \mathbf{u}_0$, becomes

$$\mathbf{v}_{SA} = \mathbf{v}_{SO} + \mathbf{u}_0 \Rightarrow v_{SA} = u_0 \pm v_{OS} \tag{16}$$

with the sign + if photon and source have opposite direction; then

$$v_{SA}T (\equiv \lambda_0) = u_0T \pm v_{OS}T \Rightarrow \lambda_0 = \lambda(1 \pm \beta) \text{ [with } \beta = v_{OS}/u_0 \text{]} \tag{17}$$

where λ_0 is the length of the emitted photons when S is in motion from O. We point out that the variation of the photons length only depends on \mathbf{v}_{OS} .

Now, the *transit time* T_t for the Observer O, can be written

$$T_0 = T \pm v_{OS}T/u_0 = T(1 \pm \beta) \text{ [with } \beta = v_{OS}/u_0 \text{]} \tag{18}$$

corresponding to the algebraic sum of the time $T (= \lambda/u_0)$ the front A needs to cover the path λ , plus the time the tail B (emitted, like every part of the photon, at speed u_0 referred to O), needs to cover the path $S_T - O = v_{OS}T$, that is $\Delta T = v_{OS}T/u_0$. (As for the observer P showed on **Figure 1**, being $\mathbf{v}_{OP} = 0$, then $T_p = T_0$).

Thus, the speed of the photon AB referred to O, since T_0 increases/decreases together with λ_0 , as per Equation (14), becomes

$$u_o = \frac{\lambda_o}{T_o} = \frac{\lambda(1 \pm \beta)}{T(1 \pm \beta)} = \frac{\lambda}{T} \equiv c \tag{19}$$

showing that *the speed of a photon referred to an Observer fixed to the source initial location, (O), is invariant despite any motion of the source with respect to O.*

The **frequency** of the light referred to a generic Observer O, on our bases, has to be defined as $\nu = n/T_t$ with n the number of photons, of the same ray, crossing the Observer during their transit time T_t . Hence, for $T_t = 1$ s, we have $\nu = n$ meaning that the frequency corresponds to the number of photons, same ray, transiting in 1 s, while, for $n = 1$, the frequency becomes

$$\nu = 1/T_t \tag{20}$$

We point out that the photons frequency emitted by a source S, under the condition $\nu_{OS} = 0$, has to be equal to the one observed by O; this 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 therefore the condition $\nu_{OS} = 0$ always implies $\nu_S = \nu_O$ whatever is the distance source-observer.

[We also point out that, according to the Relativity, (due to the *claimed* constancy of c and because of the Doppler effect), an Observer in relative motion from a source should observe different wavelength as well as different frequency for emitted light; on the contrary, on our results, if the source is fixed to its initial location (the ground on Earth), the length of the *emitted* photons is invariant, while c and ν are varying, as hereafter shown].

Referring now to **Figure 2**, let P be an observer (represented at different times, by P_A and P_B) moving with velocity \mathbf{v}_{OP} from O along the same direction of the photons while the source S is moving from O with velocity \mathbf{v}_{OS} contrary to them; we assume the photon AB totally emitted at the time the front A reaches P_A (for simplicity as $t = 0$). [In fact, after this emission, the source may even disappear].

Now, the transit time T_p of the photon AB is given, see Equation (18), by T_o plus the time T_{OP} ($= \pm v_{OP}T/c$) due to the motion of P from O, and since $\mathbf{v}_{SP} = \mathbf{v}_{SO} + \mathbf{v}_{OP}$, we can write

$$T_p = T \pm \frac{v_{SO}T}{c} \pm \frac{v_{OP}T}{c} \left(= T \pm \frac{v_{SP}T}{c} \right) = T(1 \pm \beta \pm \beta_p), \left[\text{with } \beta_p = \pm \frac{v_{OP}}{c} \right] \tag{21}$$

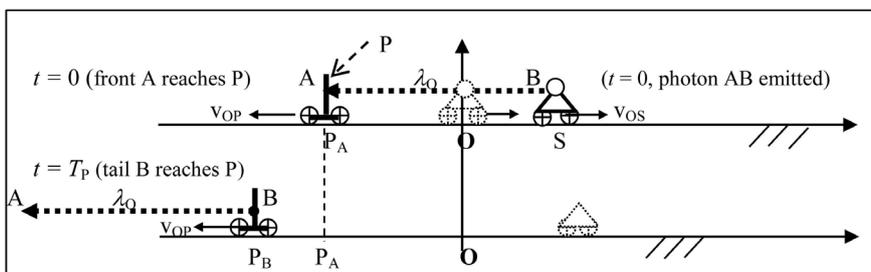


Figure 2. The Observer P moves from P_A to P_B during the transit time T_p of the photon AB while the source is moving from its initial emission location O.

$$\lambda_0 = \lambda(1 \pm \beta) \text{ length of emitted photon,}$$

$$T_s = T \text{ photon transit time for S, equal to its emission time,}$$

$$T_o = T(1 \pm \beta); T_i \text{ for O; sign + if S and photon have } \textit{opposite direction},$$

$$T_p = T(1 \pm \beta \pm \beta_p); T_i \text{ for P; } +\beta_p \text{ if P and photon have } \textit{same direction},$$

$$c_s = \lambda_o / T_s = \lambda_o / T; \text{ speed of light observed by S,}$$

$$c_p = \lambda_o / T_p \text{ speed of light observed by P,}$$

$$c_o = \lambda_o / T_o \text{ speed of light observed by O.}$$

Regarding the measurements of c through the method $c = d/t$ carried out along a double path, the light emitted inside the measurement system (MS), because of the interaction light-matter, has to be absorbed and then re-emitted by the 2nd Observer which, during the re-emission, becomes a new emitting source; therefore the above equations regarding transit time and photon length, are also valid for the re-emitted photons which now have contrary direction, hence $\beta' = -\beta$ and also $\lambda' = -\lambda_o$ giving to c , along a double path, the constant value c .

[Light emitted outside the MS: at the time the light is crossing the MS, this becomes the new emitting source].

1.6. Doppler Effect for the Light, New Equations

The Equation (17) represents our *longitudinal Doppler effect* for the light, while the general case of this effect, assuming $v_{os} \ll \lambda$ (hence $OP \cong PB$), see **Figure 4(a)**, can be written as

$$\lambda_0 = \lambda \pm v_{os}T \cos \alpha = \lambda(1 \pm \beta \cos \alpha) \quad (\text{with } \beta = v_{os}/c) \quad (23)$$

with α the angle between the direction of λ_o and \mathbf{v}_{os} .

As for the *Transverse Doppler effect*, see **Figure 4(b)**, in general, we have

$$\lambda_0 = \sqrt{\lambda^2 \pm (v_{os}T)^2} = \lambda\sqrt{1 \pm \beta^2} \quad (24)$$

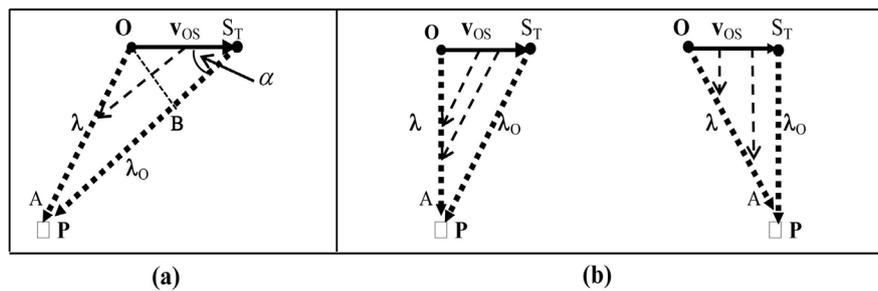


Figure 4. Doppler effect (DE). (a) General case; (b) Transverse DE with S receding/approaching an observer P. Dotted arrows inside the triangles represent the photon λ_o during its emission.

As for a *source circling around an Observer P*, the **Figure 5** shows that the length of the photon λ emitted when its source is fixed to O, becomes λ_o when S is circling with velocity \mathbf{v}_{os} .

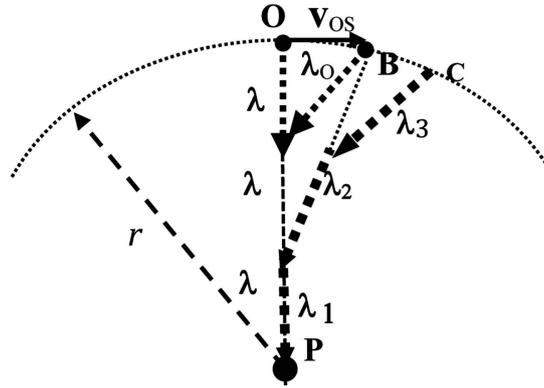


Figure 5. Photons emitted while their source is circling around P.

[The succession of the photons λ represents a ray if S is at rest with P, while the succession $\lambda_1 \rightarrow \lambda_3$ represents a ray if S is circling around P, with O, B, C the emission points of the circling source]. Then, assuming $\lambda_0 > \lambda$, we have

$$\lambda_0 = \sqrt{\lambda^2 + (v_{OS}T)^2} = \lambda\sqrt{1 + \beta^2} = \lambda\sqrt{1 + \omega^2 r^2 / c^2} \tag{25}$$

while the photon transit time, being T the emission time of λ becomes

$$T_0 = T\sqrt{1 + \beta^2} = T\sqrt{1 + \omega^2 r^2 / c^2} \tag{26}$$

with r the orbit radius, ω the source angular speed, giving to any photon, speed $c_0 = c$.

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

General Relativity predicts that the gravitational field of the Earth will cause a photon emitted downwards (towards the Earth) to be blueshifted: scope of HTE experiment was to detect this shift of light. A Mossbauer source S was placed on the top of a tower (height $h \cong 22$ m) emitting photons toward the tower base where an Absorber went out of resonance; the experiment did not clarify if the non-resonance was due to a variation of λ or ν ; indeed, because of the claimed constancy of c , both of them should have varied their initial values during the path tower-base.

According to our bases, we have different evaluations of this experiment. Let us first consider S at the base and A at its top, see **Figure 6**.

It is a fact that if S and A are at relative rest at the same level (e.g. both on the ground), then A is in resonance and it is also a fact that other experiments effected at this regard, e.g. Blatt, [7], show that *if S moves toward the absorber, not contrarily*, the absorber goes out of resonance: indeed, if S is fixed to the ground, the length of emitted photons (as previously shown) is constant, whereas if S moves with respect to its initial emission location (the ground), the photon length varies, thus we may infer that the resonance is physically related to the constancy of the length of photons.

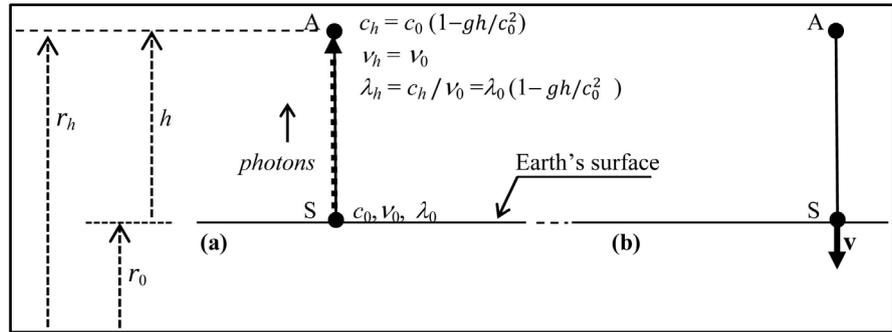


Figure 6. Harvard tower experiment scheme; source at the base, absorber A at the top, our results. (a) S and A at rest, so $\nu_h = \nu_0$; c_0, ν_0, λ_0 parameters of photons emitted by S on the ground; c_h, ν_h, λ_h photons arrived to A where $\lambda_h < \lambda_0$ thus a blue shift as for A; (b) Direction of the compensating velocity to balance the blue shift via Doppler effect, so to obtain in altitude c_0, ν_0, λ_0 .

Now, referring to **Figure 6**, if S, on the ground, emits photons reaching A at height h , because of the variation of potential, following our relation $c = (-2U)^{1/2}$, it will be $c_0 \rightarrow c_h$; since S and A are at reciprocal rest, it turns out that, as shown just after the Equation (20), it is always $\nu_h = \nu_0$ (in spite of any variation of potential between S and A) yielding $\lambda_h = c_h / \nu_h$. Therefore, with r_0 the radius of Earth (hence $r_h = r_0 + h$) and M_E the mass of Earth, writing the (11) as $c^2 = -2U$, we get $2c = -2dU/dc$ hence from r_0 to r_h and since $\Delta c = -\Delta U/c$ with $\Delta U = U_{Eh} - U_{E0} = -(M_E G/r_h) + M_E G/r_0$, we find

$$\frac{c_h - c_0}{c_0} = -\frac{\Delta U}{c_0^2} = -\frac{M_E Gh}{r_h r_0 c_0^2} \cong -gh/c_0^2 \Rightarrow c_h = c_0 (1 - gh/c_0^2) \quad (27)$$

(where $\Delta U = gh$); then for $\nu_h = \nu_0$ we have

$$\begin{aligned} \lambda_h = c_h / \nu_h &= c_0 (1 - gh/c_0^2) / \nu_0 = \lambda_0 (1 - gh/c_0^2) \\ \Rightarrow (\lambda_h - \lambda_0) / \lambda_0 &= -gh/c_0^2 = \frac{c_h - c_0}{c_0} \end{aligned} \quad (28)$$

and since $\lambda_h < \lambda_0$, *contrary* to Relativity, A observes a blue-shift effect.

Thus, to restore the resonance via Doppler Effect (DE), see **Figure 6(b)**, S has to *recede* from A in order that the *photon* length could increase, see Equation (17), from λ_h to $\lambda_0 = \lambda_h (1 + \beta)$ with $\beta = v_{AS}/c \equiv v/c$; therefore, equating the relative variation of the *photon* length due to the DE, that is $(\lambda_h - \lambda_0)/\lambda_0 = -v/c$, to the one due to the altitude, $\Delta\lambda/\lambda_0$, as given by (28), we get

$$v/c = gh/c_0^2 \Rightarrow v = gh/c_0 = 7.5 \times 10^{-7} \text{ m/s (for } h = 22.5 \text{ m)} \quad (29)$$

i.e. the value of the compensating velocity.

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 the compensating velocity \mathbf{v} with respect to the one shown on **Figure 6(b)**; at this regard, Pound-Rebka and Pound-Snider, [8] [9] [10], gave no clear indication about the direction of \mathbf{v} , since S and A, during the experiment, were moved sinusoidally.

Now, see **Figure 7**, with A on the base, and taking S to the top, the experience

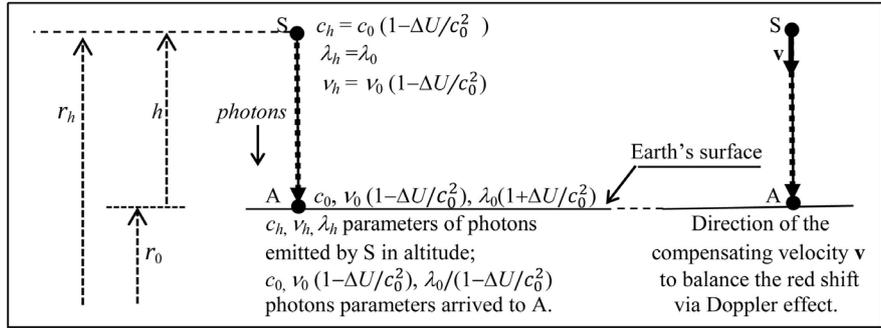


Figure 7. Harvard tower experiment scheme; source on the top, our results.

shows that the absorber goes out of resonance. Indeed, with S on the top, the (27) shows $c_h < c_0$, but what about the initial parameters of the *photons* emitted in altitude, v_h and λ_h ?

Well, it is known that atomic clocks give an increase of their counted time in altitude ($T_h > T_0$, hence $v_h < v_0$), therefore taking these clocks from ground to h , their frequency ν_h has to follow the same decrease as c_h ; this implies $\lambda_h = \lambda_0$ so the frequency of photons emitted in altitude becomes

$$\nu_h = \frac{c_h}{\lambda_h} = \frac{c_0 \left(1 - \frac{gh}{c_0^2}\right)}{\lambda_0} = \nu_0 \left(1 - \frac{gh}{c_0^2}\right) = \nu_0 \left(1 - \Delta U/c_0^2\right). \tag{30}$$

Now, with S emitting photons toward the base, since S and A are at rest, their frequency remains constant during their path top-base, meaning that $\nu_{h-0} = \nu_0 \left(1 - \Delta U/c_0^2\right)$, while the length of photons reaching the base, and considering that now h is negative, becomes

$$\lambda_{h-0} = c_0/\nu_{h-0} = c_0/\nu_0 \left(1 - \Delta U/c_0^2\right) = \lambda_0 \left(1 + gh/c_0^2\right) \tag{31}$$

showing an increase of λ from the top to the base. Hence the absorber, on the base, will state, **contrary to GR**, a red-shift, hence, to compensate it via Doppler shift, see **Figure 7**, S has now to move toward A; *on the contrary, according to GR, A and S should recede from each other*. We also highlight two points:

- The increase of λ for photons moving from h to the ground, gives a reason to the gravitational red shift related to far sources.
- The decrease of ν during the path h -ground gives a reason to the lower frequency of the light coming from far sources.

Time dilation: Atomic clocks in altitude (h -clocks) are ticking *faster* than identical clocks on the ground (g -clocks): at height h , see (27), we have $(c_h - c_0)/c_0 = -\Delta U/c_0^2$, while taking a clock to a GPS satellite, see also **Figure 7(a)**, from (30), one finds

$$T_h = T_0 \sqrt{\left(1 - \frac{\Delta U}{c_0^2}\right)} = T_0/(1 - \delta) \Rightarrow T_h - \delta T_h = T_0 \text{ [where } \frac{\Delta U}{c_0^2} \equiv \delta \text{]} \tag{32}$$

with T_h the counted time of one photon emitted by a h -clock, while T_0 by a g -clock. Thus the variation of the counted time between the two clocks, for *every*

emitted photon, due to the altitude, becomes

$$\Delta T_{\text{ph}} = T_h - T_0 = T_h \delta \tag{33}$$

and since the frequency of photons is their number emitted in 1 s along one ray, the term

$$n_{1s} \equiv \nu_0 t_{1s} \quad (\text{with } t_{1s} = 1 \text{ s}) \tag{34}$$

is the number of photons (atomic transition of Cs 137) constituting one-second on the ground; then, since $\nu_h = \nu_0 (1 - \Delta U/c_0^2)$, see (30), the following relation

$$\Delta n_{1s} = \nu_h \Delta T_{\text{ph}} = \frac{\nu_0 \left(1 - \frac{\Delta U}{c_0^2}\right) \left(T_0 \frac{\Delta U}{c_0^2}\right)}{1 - \frac{\Delta U}{c_0^2}} = \nu_0 T_0 \frac{\Delta U}{c_0^2} = \frac{\Delta U}{c_0^2} \tag{35}$$

is the variation of n_{1s} emitted in 1 s by a h -clock; now, see (27), $\Delta U = M_E Gh/r_h r_0$ 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

$$\Delta T_{1d} = \Delta n_{1s} \times 86400 \text{ s} = 86400 \Delta U/c_0^2 = 45.5 \mu\text{s} \tag{36}$$

hence this effect is a consequence of the variation of U ; indeed, as shown later on, the values of the H atom frequencies depend on c , thus, on our bases, on U .

Now let us find the variation of the counted time, between the two clocks, due to their relative motion; thus, being $v_s = 2 (2\pi r_h/86,400 = 3870$ m/s the orbital speed of GPS satellites, (corresponding to two orbits/day), it turns out that the counted time variation, between a h -clock and an Observer E at the centre of Earth, due to their relative motion, is given by Equation (26) which, in our case, with $\beta_s = v_s/c (\cong 1.3 \times 10^{-5})$ becomes

$$T_E = T_h \sqrt{1 + \beta_s^2} \cong T_h \left(1 + \frac{\beta_s^2}{2}\right) \quad (\text{valid for } \beta_s^2 \ll 1) \tag{37}$$

with T_E the photon counted time for the Observer E; then, with v_0 the Earth's rotational speed ($\cong 460$ m/s at the equator), since $\beta_0^2 = (v_0/c)^2 \ll \beta_s^2 = (v_s/c)^2$ and calling $T_0 \cong T_h (1 + \beta_0^2)$ the photon counted time of a g -clock with respect to a clock at the Earth's centre E, we can write $T_0 \cong T_E$; thus, the difference between the two transit times T_h and $T_0 (\cong T_E)$ due to their relative motion, is

$$\Delta T'_{\text{ph}} = T_h - T_0 \cong T_h - T_E = T_h - T_h \left(1 + \frac{\beta_s^2}{2}\right) = -T_h \beta_s^2 / 2. \tag{38}$$

Then, as above, $\Delta n'_{1s} \equiv \nu_h \Delta T'_{\text{ph}} = -\nu_h T_h \beta_s^2 / 2 = -\beta_s^2 / 2$ 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, is

$$\Delta T'_{1d} = -\left(\frac{\beta_s^2}{2}\right) 86400 \text{ s} = -7.2 \mu\text{s} \tag{39}$$

showing a decrease of the counted time for a g -clock due to their relative mo-

tion; hence

$$\Delta T_{\text{totld}} = \Delta T_{\text{ld}} + \Delta T'_{\text{ld}} = 38.3 \mu\text{s/day} \tag{40}$$

which is also predicted, (with different reason), by GR. To prevent this effect, before launching, the daily counted time (T_{ld}) of clocks, has to be decreased by $\cong 38 \mu\text{s}$.

In short, the *time dilation* is a consequence of the variation of U , hence of c : indeed, as show on §2.3, the admitted/emitted frequency on H atom (and of course the one of the other elements) varies together with c .

Gravitational redshift

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 $v = v_0$, we get $c/\lambda = c_0/\lambda_0$, where v_0 , c_0 and λ_0 are the values on Earth, hence for $c_0 > c$ one gets $\lambda_0 > \lambda$, that is a red shift observed on Earth; therefore, the shifts here observed can be expressed as

$$z \equiv \frac{\Delta\lambda}{\lambda} = \frac{\Delta c}{c} = \frac{c_0 - c}{c} = \frac{c_0}{c} - 1 = \sqrt{U_0/U} - 1 \tag{41}$$

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. In particular, with s the distance Earth-source, for $s < \cong 45$ Mpc, [11], (roughly corresponding to $-0.01 < z < +0.01$) if U (potential on the source) is, in *absolute value*, higher than the potential on Earth U_0 , the (41) 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 with respect to $|U_0|$. In the range $\cong 0.01 < z < \cong 0.20$, (where z follows the Hubble’s law), the (41), written as

$$U = U_0 / (1+z)^2 \cong U_0 / (1+2z) \cong U_0 (1-2z) \text{ (valid for } z \ll 1) \tag{42}$$

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

[For $s > \cong 45$ Mpc, z is always positive, hence we may infer that our galaxy is practically near/close to the middle of the masses of universe (where $|U|$ has the max value)].

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

blue/redshift	z	s (Mpc)	$U/U_0 = 1/(z+1)^2$	$U/U_0 \cong 1-2z$ valid for $z \ll 1$	$c/c_0 \cong 1/(z+1)$
blue/red shift	$-0.01 \rightarrow 0.01$	$< \cong 45$	0.98-1.02	0.98-1.02	0.99 - 1.01
red shift	$\cong 0.01$	$\cong 45$	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	$\rightarrow \infty$	$\rightarrow \infty$	$\rightarrow 0$		$\rightarrow 0$

2. Interaction Light-Matter

2.1. 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 8(a)**, in a *radial way*, (giving origin to the radial velocity \mathbf{w}), otherwise, other impacts could cause the electron fall into the nucleus, due, for instance, to an impact where the velocity of photons and electron have contrary direction.

To be radial, the impact must occur in a specific point, fixed to the electron surface, we call it *Impact Point*, which, *during the electron, orbit*, has to face its nucleus, (up to its removal), giving to the electron one rotation every orbit; the impacting photons have to approach the nucleus, as shown on **Figure 8(b)**, perpendicularly to the electron orbit plane, providing, to the electron, a radial velocity \mathbf{w} .

Moreover, we can infer that the charge of the electron, has to correspond to the Impact Point (I_p), so we may infer that each photon *front* is provided with a positive charge, while its *tail* with an equal negative one. In fact, the photon may be represented as an electric bipole.

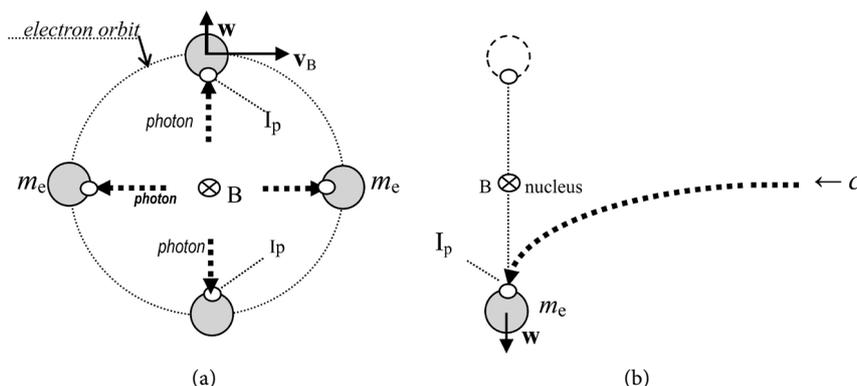


Figure 8. Photon-electron Impact point (I_p) and electron *radial* velocity \mathbf{w} . (a) Electron orbit front view; (b) Side view.

2.2. Physical Characteristics of Photons

The total energy of a mass m is $E = mc^2$ also proved [12] by the evidence of nuclear reactions like $n + pd + \gamma$, hence this energy has to be valid for the (massive) light too, thus writing their energy as $E = \frac{1}{2}mc^2 + \frac{1}{2}mc^2$ we have to infer that photons are provided, out of their kinetic energy $K_c = \frac{1}{2}mc^2$ with an *internal* energy K_i equal to K_c and we point out that, toward the infinity, (where $U_\infty \rightarrow 0$ hence $c_\infty \rightarrow 0$), both K_c and K_i tend to 0; then, since for the light $E = h\nu$, the following relation

$$E = K_c + K_i = mc^2 = h\nu \quad (43)$$

has to represent the energy of *one* ray of light, (where photons are flowing), and

where

$$m = h\nu/c^2 \equiv \gamma\nu \quad (44)$$

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

$$\gamma = h/c^2 = m/\nu = mT = 7.372495 \times 10^{-51} \text{ kg s} \quad (45)$$

represents the mass of one photon crossing an observer during the transit time T , while the Planck's constant

$$h = \gamma c^2 \quad (46)$$

turns out to be the energy of one photon (mass of light of one ray passing during T).

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

$$n_r mc^2 = P \quad (47)$$

therefore

$$m_{\text{tot}} = n_r m = P/c^2 \quad (48)$$

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

$$m_{\text{tot}} = P/c^2 \cong 1.1 \times 10^{-17} \text{ kg s}^{-1} \quad (49)$$

while the number n_r of rays is

$$n_r (= m_{\text{tot}}/\gamma\nu) = P/c^2 \gamma\nu = P/h\nu \quad (50)$$

in our case, $n_r \cong 3 \times 10^{18}$ 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 (50) written as $n_r \nu = P/h$. Then, the number of photons n_γ emitted in 1 s becomes

$$n_\gamma = (n_r \nu) = P\nu/h\nu = P/h \quad (51)$$

which, for $P = 1 \text{ W}$, gives $n_\gamma = h^{-1}$ ($= 1.5 \times 10^{33}$ 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 photons-electron, (like on absorption or photoelectric effects), both kinetic and internal energy of the light are involved, so the momentum transferred to the electron is

$$\mathbf{p} = 2m\mathbf{c} = 2\gamma\nu\mathbf{c} = 2\gamma\mathbf{c}/T \quad (52)$$

whose validity is confirmed, see **Table 2** of chapter 2.4, by the equality $w_{137} = v_{137}$ (with v_{137} the electron orbital speed along the H atom orbit # 137 and where w_{137} is the value of the electron radial speed along such orbit, as a condition for the H atom ionization.

Regarding elastic impacts, the momentum transferred to the electron, is

$$\mathbf{p}' = m'\mathbf{c} = \gamma v'\mathbf{c} = \gamma \mathbf{c}/T' \tag{53}$$

either for *incident* or for *reflected photons*, with T' the total impact time for this interaction; through the (53), and also through *our* Doppler effect equation, see (17), we got the Compton equation (which cannot be obtained by the Relativity via their Doppler effect equations).

2.3. H Atom Parameters and Meaning of Quantum Numbers

Figure 9(a) represents, on our bases, the H atom *basic* configuration; on the intermediate conf. **(b)** the electron is represented circling along the same orbit as its charge, while on conf. **(c)** the electron reduced mass $m_r = m_e/(1 + m_e/m_p) = m_e/(1 + \epsilon_m)$, with $\epsilon_m = m_e/m_p$, circling around the proton mass m_p fixed as origin, is represented either along the effective orbit r'_0 or along r_0 ; referring to conf. **(a)** we define:

- m_e : electron mass;
- m_p : proton mass;
- $v_e = |\mathbf{v}_e|$ electron ground-state (orbital) speed,
- $v_p = |\mathbf{v}_p|$ proton ground-state speed,
- r_B the ground-state orbit of the electron charge,
- r_e the electron radius,
- $\epsilon_r \equiv r_e/r_B$
- $r'_B = (r_B + r_e) = r_B(1 + \epsilon_r)$, ground-state orbit of the electron barycentre,
- r_p the proton ground-state orbit.

Now, the constancy of momentum referred to conf. **Figure 9(a)** gives

$$m_e v_e = m_p v_p \Rightarrow v_p = m_e v_e / m_p \equiv \epsilon_m v_e \tag{54}$$

then, equating on **(a)** the frequency of m_e and m_p , we get

$$v_e / r'_B = v_p / r_p \Rightarrow r_p (v_p / v_e) r'_B = \epsilon_m r'_B = \epsilon_m r_B (1 + \epsilon_r) \tag{55}$$

The conf. **(a)**, moving m_e (without its charge) from the orbit r'_B to r_B (the electric forces acting on m_e are not involved), turns to conf. **(b)** where the equality between the frequency of m_e and the one of its charge, gives

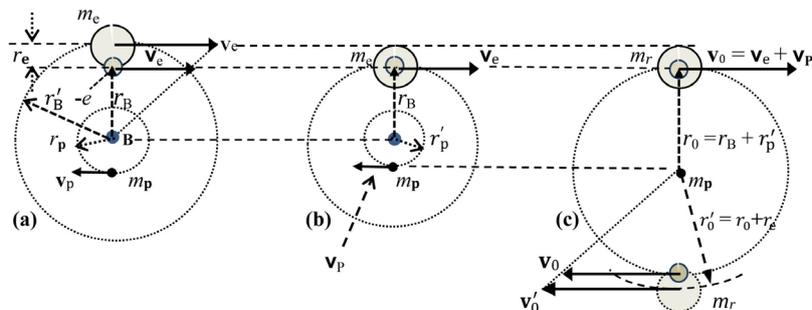


Figure 9. H atom equivalent configurations, on our bases. (a) Observed from the electron-proton common centre of gravity B; (b) Ditto, with the electron barycentre now coincident with its proper charge; (c) Observed from the proton fixed as origin, orbited by the electron reduced mass m_r , represented either circling along r_0 or its effective orbit r'_0 .

$$v_e/r'_B = v_e/r_B \Rightarrow v_e = v_e/(1 + \epsilon_r) \tag{56}$$

then the constancy of momentum referred to conf. (b), $m_e v_e = m_p v_p$, yields

$$v_p = m_e v_e / m_p = \epsilon_m v_e \Rightarrow v_p / v_e = \epsilon_m \tag{57}$$

then, equating on (b) the frequency of m_e and m_p , we get

$$v_e / r_B = v_p / r'_p \Rightarrow r'_p = (v_p / v_e) r_B = \epsilon_m r_B \tag{58}$$

and finally, see conf. (c), we find

$$r_0 = r_B + r'_p = r_B + r_B \epsilon_m = r_B (1 + \epsilon_m) = r'_B (1 + \epsilon_m) / (1 + \epsilon_r) \tag{59}$$

where m_r is circling with speed $v_0 = v_e + v_p = v_e (1 + \epsilon_m)$; then

$$r'_0 = r_0 + r_e = r_0 + \epsilon_r r_B = r_0 [1 + \epsilon_r / (1 + \epsilon_m)] = r_0 (1 + \epsilon_m + \epsilon_r) / (1 + \epsilon_m) \tag{60}$$

Now, it is known that, on H atom, the admitted frequencies have to satisfy the relation

$$\nu_n = \nu_0 / n^2 \quad (n = 1, 2, 3, \dots) \tag{61}$$

with ν_n the *photons* admitted frequency along the n -th circular orbit and since, as claimed on Section 1.4, $\nu (=n/t)$ is the number of *photons* (of the same ray) crossing an observer during the time t , the integer n represents the number of *photons* absorbed by the electron during the photon-electron impact time t and *this number, for all the H atom circular orbits, is an integer starting with 1 along the electron ground-state orbit.*

The massiveness of light implies a finite impact time during which the electron is circling, and supposing, for now, that, for $n = 1$, the photon frequency ν_0 should be equal to the electron frequency along the ground-state orbit, that is $\nu_{e0} = \nu_0 / 2\pi r_0$, where r_0 , see conf. (c) is the electron ground-state orbit, with v_0 its orbital speed, we could write

$$\nu_0 / \nu_{e0} = 1 \quad (\text{first assumption}); \tag{62}$$

to verify this ratio or to find the correct value, we may start from the experimental value of the ^1H ground-state ionization energy W_0 (electron extraction work) corresponding to

$$W_0 = -U_{r_0} / 2 = e^2 / 8\pi\epsilon_0 r_0 = \frac{1}{2} m_r v_0^2 \cong 13.8954 \text{ eV} \tag{63}$$

with $U_{r_0} = -e^2 / 4\pi\epsilon_0 r_0$ the potential of the dipole electron-proton, yielding

$$r_0 = e^2 / W_0 8\pi\epsilon_0 \cong 5.29461 \times 10^{-11} \text{ m} \tag{64}$$

(rough value of the Bohr radius), thus the orbital speed of the electron along r_0 becomes

$$v_0 = \sqrt{e^2 / 4\pi\epsilon_0 r_0 m_r} \cong 2.18770 \times 10^6 \text{ m/s} \tag{65}$$

Then, if W_0 is supplied by one ray of light (with energy $E = h\nu_0$) it must be

$$\frac{1}{2} m_r v_0^2 = h\nu_0 \Rightarrow \nu_0 = m_r v_0^2 / 2h \cong 3.28808 \times 10^{15} \text{ s}^{-1} \tag{66}$$

with ν_0 the admitted frequency along r_0 ; hence, the ratio ν_0 / ν_{e0} becomes

$$v_0/v_{e0} = (T_{e0}/T_0) = v_0 2\pi r_0/v_0 = 0.499998 \quad (67)$$

meaning that during one electron orbit it should transit *half* of a photon, so we may infer that along r_0 it should be

$$2T_{e0}/T_0 = 2v_0/v_{e0} = 1 \quad \text{exact} \quad (68)$$

meaning that, along r_0 the impact time T_0 lasts for two electron *circular* orbits.

Now, see conf. (c) equating along r_0 the electron centrifugal force to the Coulomb force we have

$$m_r v_0^2/r_0 = \frac{e^2}{4\pi\epsilon_0 r_0^2} \Rightarrow m_r v_0^2 = e^2/4\pi\epsilon_0 r_0 = -U_{r_0} \quad (69)$$

which, for a circular orbit, and since, see (66), $m_r v^2 = 2h\nu$, gives

$$v_n = e^2/4\pi\epsilon_0 r_n 2h \quad (70)$$

then

$$r_n = e^2/8\pi\epsilon_0 h v_n = e^2 n^2/8\pi\epsilon_0 h v_0 = r_0 n^2 \quad (71)$$

while as for the orbital speed of the electron m_r along any circular orbit r_n the (65) gives

$$v_n^2 = e^2/4\pi\epsilon_0 r_n m_r = e^2/4\pi\epsilon_0 r_0 n^2 m_r = v_0^2/n^2 \Rightarrow v_n = v_0/n \quad (72)$$

and finally the electron frequency along a circular orbit becomes

$$v_{en} = v_n/2\pi r_n = v_0/n 2\pi r_0 n^2 = v_{e0}/n^3. \quad (73)$$

Now, along r_0 , the (70) yields

$$v_0 = e^2/4\pi\epsilon_0 r_0 2h = e^2 c/2\epsilon_0 h c 4\pi r_0 = \alpha c/4\pi r_0 \quad (74)$$

with $\alpha = e^2/2\epsilon_0 h c$ the fine structure constant and given $2v_0/v_{e0} = 1$ (exact) we have

$$\delta_1 \equiv 2v_0/v_{e0} = (2\alpha c/4\pi r_0)/(v_0/2\pi r_0) = \alpha c/v_0 = 1 \quad (75)$$

yielding

$$v_0 = \alpha c = e^2/2h\epsilon_0 = 2187691.2 \text{ m/s} \quad (76)$$

and then the (66) becomes

$$v_0 = m_r v_0^2/2h = m_r \alpha^2 c^2/2h = R_H c \quad (77)$$

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

Now, from (61) and (73), because of the ratio $\delta_1 \equiv 2v_0/v_{e0} = 1$, we also get

$$\delta_n \equiv 2v_n/v_{en} = (2v_0/n^2)/(v_{e0}/n^3) = n \quad (\text{with } n = 1, 2, 3, \dots) \quad (78)$$

which written as $nT_n = 2T_{en}$ shows that the impact time nT_n of n photons (with frequency v_n) equals the time the electron needs for two orbits along any circular orbit r_n .

Now the correct value of r_0 , from (71), becomes

$$r_0 = \frac{e^2}{8\pi\epsilon_0 h v_0} = \frac{e^2}{8\pi\epsilon_0 h R_H c} = \frac{\alpha}{4\pi R_H} = 5.294654 \times 10^{-11} \text{ m} \quad (79)$$

which should represent the electron ground state orbit if the electron should circle, together with its charge, around r_0 ; indeed the ground-state effective orbit of the electron barycentre observed from m_p is r'_0 . Then, writing the (59) as $r_B = r_0/(1 + \epsilon_m)$ we get

$$r_B = \frac{r_0}{1 + \frac{m_e}{m_p}} = \alpha/4\pi R_H (1 + \epsilon_m) = \frac{\alpha}{4\pi R_\infty} = 5.291772 \times 10^{-11} \text{ m} \quad (80)$$

corresponding to the Bohr radius which, on our results, is the orbit of the electron charge referred to B (centre of mass of the system electron-proton) see **Figure 9(a)**.

Now, still referring to conf. (c), the effective electron orbit (*i.e.* its barycenter) is r'_0 where its effective speed is

$$\begin{aligned} v'_0 &= \frac{v_0 r'_0}{r_0} = \frac{v_0 (r_0 + r_e)}{r_B (1 + \epsilon_m)} = v_0 [r_B (1 + \epsilon_m) + \epsilon_r r_B] / r_B (1 + \epsilon_m) \\ &= \frac{v_0 (1 + \epsilon_m + \epsilon_r)}{1 + \epsilon_m} = \alpha c \left(1 + \frac{\epsilon_r}{1 + \epsilon_m} \right) \end{aligned} \quad (81)$$

and since the distance between the electron charge and the proton charge is r_0 (either considering the electron circling along r'_0 or r_0), it turns out that along r'_0 the photon admitted frequency is $v'_0 = v_0$, and therefore we get

$$\delta'_1 = \frac{2v_0}{v'_{e0}} = 2v_0 / (v'_0 / 2\pi r'_0) = 2v_0 \left/ \frac{v_0 r'_0}{r_0} \right/ 2\pi r'_0 = 2v_0 2\pi r_0 / v_0 = 1 \quad (82)$$

meaning *one* photon every two electron ground-state orbit, and since $r'_0 = (r_0 + r_e)$ is also a circular orbit, the *effective* electron orbit r'_n has following parameters:

$$r'_n = r'_0 n^2; \quad v'_n = v'_0 / n; \quad v'_{en} = v'_{e0} / n^3; \quad v'_n = v_n \quad (83)$$

thus for each circular orbit we get

$$\delta'_n = \frac{2v_n}{v'_{en}} = (2v_0 / n^2) / (v'_{e0} / n^3) = 2mv_0 / v'_{e0} = n \quad (84)$$

the same as along r_n .

2.4. Electron Radial Speed, Ionization Condition, Electron Radius

To apply properly the Conservation of momentum (CoM) to the impact photon-electron, the atom nucleus has to be considered fixed as origin in the common centre of gravity nucleus-electrons. On H atom, referring to **Figure 9(c)**, an inelastic impact photon-electron, since photon and \mathbf{w} , see **Figure 8**, have same direction, the (52), gives

$$w = 2mc/m_r = 2\gamma v c/m_r = 2\gamma v c^2/cm_r = 2h\nu/cm_r \quad (85)$$

where the frequency ν , see (70), depends on the effective distance r between the proton and the electron charge, while the term w , see also **Figure 10**, is the electron *radial* speed originated by the impact of **one photon** during the impact time $T (= 1/\nu)$; for n photons of the same ray the (85) gives

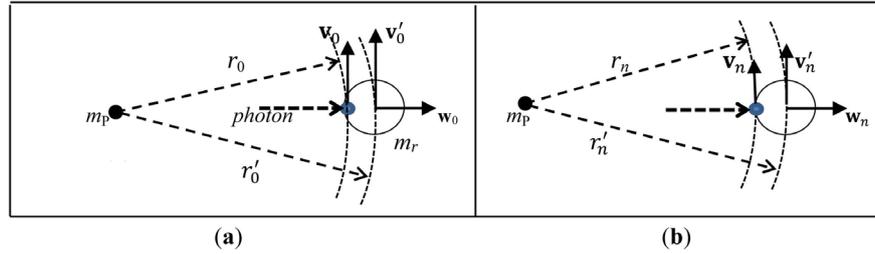


Figure 10. H atom: orbital and radial electron speed, see also **Figure 9(c)**. (a) Along r_0 we have: $v_0 = \alpha c$; $w_0 = \alpha^2 c$; then, along r'_0 we will find $v'_0 = c/137$; (b) Along the ionization orbit: $w_{n^2} = v'_n = c/137^2$.

$$w_n = nw = 2nhv/cm_r \tag{86}$$

while the generic condition

$$w = v \text{ (ionization condition)} \tag{87}$$

where v is the electron speed along the ionization orbit, represents the sufficient condition for an electron to escape from its atom, (with zero final velocity of the electron, like on Absorption effect and, of course, for H atom).

Now, writing the (66) as $v_0 = m_r v_0^2 / 2h$, the (85) leads to

$$w_0 = \frac{2hm_r v_0^2}{2hcm_r} = v_0^2 / c = \alpha^2 c = 15964.35 \text{ m/s} \cong c/137^2 \tag{88}$$

thus the ionization condition along r_0 , for one photon only, becomes

$$\frac{w_0}{v_0} = \frac{v_0}{c} = \alpha \cong 1/137 \ll 1 \tag{89}$$

hence the ionization, requiring $w/v=1$, could happen for $n = 137$, but the number of admitted photons, along r_0 , is $n = 1$. Now, along the progressive orbit # n , the admitted photons frequency is $v_n = v_0/n^2$, and since n is the number of admitted photons along each electron circular d-orbit, we may infer that each progressive orbit is composed of n electron d-orbits, yielding n^2 admitted photons along each of these orbits.

Referring now to the electron effective ground-state orbit r'_0 , regarding the orbit $r'_n \cong r'_0 n^2$, where $v'_n = v'/n$, the (86), for n^2 photons, gives

$$w_{n^2} (=nw_{\#n}) = \frac{n^2 2hv'_n}{cm_r} = \frac{n^2 2hv'_0}{cm_r n^2} = \frac{2hv'_0}{cm_r} \tag{90}$$

constant along every circular orbit, and where v'_0 from (66) becomes

$$v'_0 = m_r v_0'^2 / 2h \tag{91}$$

which represents the photon *virtual* frequency, intending the admitted frequency if the electron charge would be coincident with the electron barycenter along its effective orbit r'_0 ; indeed, the photons admitted frequency is related to the effective distance r_0 , where the effective photon frequency is therefore v_0 . In fact, we introduce v'_0 to determine the value of v'_0 (ground-state electron effective orbital speed).

Therefore the ionization condition along r'_n becomes

$$w_{n^2} = v'_n = v'_0/n \tag{92}$$

yielding

$$2hv'_0/cm_r = v'_0/n \Rightarrow n = v'_0cm_r/2hv'_0 \tag{93}$$

then

$$n = v'_0cm_r/2h/2hm_rv_0^2 \Rightarrow n = \frac{c}{v'_0} \cong \frac{c}{v_0} = \frac{c}{\alpha c} \cong 137 \tag{94}$$

but n has to be in integer, so we can infer $n = c/v'_0 = 137$ and therefore we get

$$v'_0 = c/137 \tag{95}$$

representing the electron speed along its effective ground-state orbit, while

$$v'_{137} = v'_0/137 = c/137^2 \tag{96}$$

represents the electron speed along its ionization orbit, see also **Table 2**.

Then, since $v'_0 = \alpha c \left(1 + \frac{\epsilon_r}{1 + \epsilon_m}\right)$ we obtain

$$\frac{c}{137} = \frac{\alpha c(1 + \epsilon_m + \epsilon_r)}{1 + \epsilon_m} \tag{97}$$

then

$$1 + \epsilon_m + \epsilon_r = \frac{(1 + \epsilon_m)}{137\alpha} \Rightarrow \epsilon_r = (1 + \epsilon_m) \left(\frac{1}{137\alpha} - 1\right) = 0.0002629141 \tag{98}$$

and since, for definition, $r_e = \epsilon_r r_B$, we get

$$r_e = \epsilon_r r_B = \frac{\epsilon_r \alpha}{4\pi R_\infty} = (1 + \epsilon_m) \left(\frac{1}{137\alpha} - 1\right) \alpha / 4\pi R_\infty = \left(\frac{1}{137\alpha} - 1\right) \alpha / 4\pi R_H \tag{99}$$

and since $4\pi R_H = \alpha/r_0$ we also get

$$r_e = \left(\frac{1}{137\alpha} - 1\right) r_0 = 1.391281 \times 10^{-14} \text{ m (electron radius)} \tag{100}$$

Table 2. Parameters of H atom circular orbits up to the ionization, our results.

Progressive number of each circular d-orbit n-th	Total number of admitted photons along each orbit n^2	Photons effective frequency along orbit r_n $v_n = v_0/n^2$	Photons virtual Frequency along each orbit r'_n $v'_n = v'_0/n^2$	Electron radial speed due to n^2 photons $w_{r^2} = 2hv'_0/cm_r$	Electron orbital speed $v'_0 = c/137$ $v'_n = v'_0/n$
-	-	($\times 10^{10}$ Hz)	($\times 10^{10}$ Hz)	m/s	m/s
1 st	1	328,805.1	328,977.9	15,972.74	2,188,266
2 nd	4	82,201.3	82,244.4	15,972.74	1,094,133
...
137th	137 ²	17.52	17.53	15,972.74	15,972.74

2.5. Absorption/Emission Effect; Claimed Fall of Circling Electrons

Referring to **Figure 11** representing the Absorption of *photons* into a circling 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

$$T = E + U_r + K_e + K_r \tag{101}$$

where $E (=mc^2)$ is the energy of the incident light, $U_r (= -e^2/4\pi\epsilon_0 r)$ is the *potential* due to electrostatic attraction acting on the electron, $K_e (=1/2 m_e v^2)$ is the electron *orbital* kinetic energy, and $K_r (=1/2 m_e w^2)$ its *radial* kinetic energy related to its radial speed w due to the impact photon-electron.

Regarding the Absorption/Emission effect (elements on gaseous state), see **Figure 11**, along circular orbits it is $K_r = 0$ and moreover, at the end of absorption, along the orbit r_2 , (where the photons have been absorbed), it is $E_2 = 0$; hence *between two circular orbits* r_1 and r_2 , the (101) gives

$$E_1 + U_{r1} + K_{e1} = U_{r2} + K_{e2} \tag{102}$$

Now, from (69) $U_r = -m_e v^2$ and since $K_e = 1/2 m_e v^2$, we get $(U_r + K_e) = -1/2 m_e v^2$ thus from (102) we get $E_1 - 1/2 m_e v_1^2 = -1/2 m_e v_2^2$; so, as $E_1 = h\nu$, and since $m_e v^2 = e^2/4\pi\epsilon_0 r$ we find

$$h\nu = 1/2 m_e v_1^2 - 1/2 m_e v_2^2 = \frac{e^2}{8\pi\epsilon_0} \left(\frac{1}{r_1} - \frac{1}{r_2} \right) \tag{103}$$

Then, according to (71) we have $r_1 = r_0 n^2$ and $r_2 = r_0 k^2$ (with $k > n$ as $r_2 > r_1$), thus

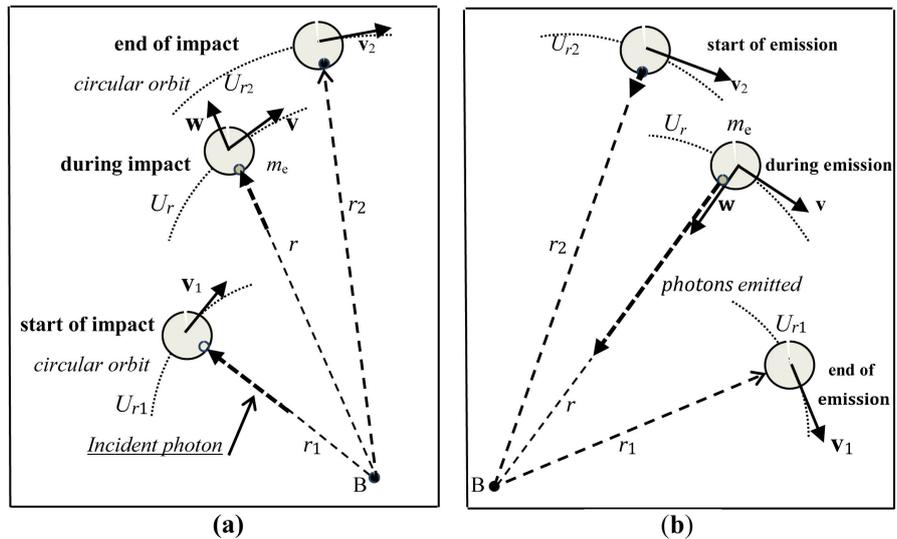


Figure 11. Absorption/Emission effect: (a) Incident photons are absorbed by the electron which moves toward wider orbits; (b) Emission: the electron moves toward inner orbits emitting photons.

$$\nu = \left(\frac{e^2}{8\pi\epsilon_0 h r_0} \right) \left(\frac{1}{n^2} - \frac{1}{k^2} \right) \quad (104)$$

and plugging the (74) written as $\nu_0 = e^2/8\pi\epsilon_0 h r_0$, we find

$$\nu = \nu_0 \left(\frac{1}{n^2} - \frac{1}{k^2} \right) \quad (105)$$

which is the *photons* frequency between two circular orbits, where n represents the progressive specific number of each circular orbit and where k turns out to have, for each of them, the values $k = n + 1, n + 2, \dots, n_i$ which are, one by one, the number of the *remaining* external circular orbits, and where n_i is the ionization orbit; on H atom, $n_i = 137$.

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* cannot happen along circular orbit, that is why the circling electrons are absorbing/emitting *photons* only *between* circular orbits, and therefore, the e.m. radiation is due to the emitted *photons* during their re-entry toward inner orbits; at this regard, *the photons emission is necessary for the electrons not to fall into their nucleus.*

2.6. Photoelectric Effect: Number of Involved Photons

Between the electron ground-state orbit r_0 and its extraction orbit $r \rightarrow \infty$ (intending on microscopic scale), the (101), valid for *every* interaction light-matter, gives

$$E + U_{r_0} + K_{e0} + K_{r_0} = E' + U_{r \rightarrow \infty} + K_{e\infty} + K_{ae} \quad (106)$$

where E' is the energy of re-emitted light, $K_{ae} = \frac{1}{2}m_e w_{ae}^2$ the electron kinetic energy after its extraction (intending on macroscopic scale), w_{ae} its related radial speed, while the other terms have been defined referring to (101).

On ground-state, as also shown between Equations (102) and (103), it is

$$U_{r_0} + K_{e0} = -m_e v_0^2 + \frac{1}{2}m_e v_0^2 = -\frac{1}{2}m_e v_0^2 = -W_f \quad (107)$$

with v_0 the electron speed along r_0 and W_f the work function (electron extraction work); now, at the start of impact it is $w = 0$ giving $K_{r_0} (= \frac{1}{2}m_e w^2) = 0$ while for $r \rightarrow \infty$, the electron orbital speed $v_\infty \rightarrow 0$, so

$$(U_{r \rightarrow \infty} + K_{e0}) = -\frac{1}{2}m_e v_\infty^2 \rightarrow 0 \quad (108)$$

hence the (106) gives

$$E - W_f = E' + K_{ae} \Rightarrow E = E' + W_f + K_{ae} \quad (109)$$

where $W_f + K_{ae}$ is the total kinetic energy transferred from light to electron, that is the sum of the sufficient energy to remove the electron plus the one to give it the energy after extraction.

On Photoelectric Effect (PhE), the light scatters off an electron ($K_{ae} \geq 0$), but it is not re-emitted, hence $E' = 0$, so the (109), with $\nu_f (= W_f/h)$ the specific threshold frequency, becomes

$$E = W_f + K_{ae} \Rightarrow h\nu = h\nu_f + \frac{1}{2}m_e w_{ae}^2 \quad (110)$$

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 (85), is $w_f = 2h\nu_f/m_e c = 2W_f/m_e c$, and writing the (66) as

$$v_0 = (2h\nu_f/m_e)^{1/2} = (2W_f/m_e)^{1/2} \quad (111)$$

we get

$$\frac{w_f}{v_0} = \frac{\left(\frac{2W_f}{m_e c}\right)}{\left(\frac{2W_f}{m_e}\right)^{1/2}} = \left(\frac{2W_f}{m_e}\right)^{1/2} / c = \frac{v_0}{c} \Rightarrow w_f = \frac{v_0^2}{c} \quad (112)$$

which is equal to (88), and since the values of W_f are in the range $\cong 2 - 6$ eV, the Equation (112) gives $w_f/v_0 \cong 0.0028 - 0.0048$ meaning that the ionization (which for elements on solid state where electrons are circling along fixed orbits requires $w = v_0$), at frequency ν_f needs n_f *photons*: indeed, the electron radial speed due to n_f *photons* with frequency ν_f , see (86), is

$$w_{nf} = n_f w_f = n_f 2W_f/m_e c \quad (113)$$

so the ionization condition becomes $w_{nf} = v_0$ leading to

$$n_f 2W_f/m_e c = (2W_f/m_e)^{1/2} \text{ giving} \\ n_f = c/\sqrt{2W_f/m_e} = c\sqrt{m_e/2W_f} = v_0/w_f = c/v_0 \quad (114)$$

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

$$n_f \nu_f \equiv \nu_1 \quad (115)$$

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

To find the number n_1 related to the frequency ν_1 let us equate the (66) written as $v_0 = \sqrt{2h\nu_1/m_e}$, to the electron radial speed due to n_1 photons, $w_{n1} = 2n_1 h\nu_1/cm_e$ yielding $(2h\nu_1/m_e) = (2n_1 h\nu_1/cm_e)^2$ and then

$$n_1^2 = \frac{m_e c^2}{2h\nu_1} = \frac{m_e c^2}{2hn_1 \nu_f} = \frac{m_e c^2}{2n_1 W_f} \Rightarrow n_1 = c\sqrt{m_e/2n_1 W_f} \quad (116)$$

and plugging $W_f = c^2 m_e / 2n_f^2$ as given by (114), we find

$$n_1 = \sqrt{n_f} \quad (117)$$

For instance as for caesium (Cs), having W_f 1.95 eV, since $n_f = c(m_e/2W_f)^{1/2} \cong 361.9$ we may infer $n_f = 361$ leading to $n_1 = 19$, while as for Be or Co, having $W_f \cong 5$ eV we may infer $n_f = 225$ leading to $n_1 = 15$.

2.7. Compton Effect and Its 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 \mathbf{w} , implying an *undoubted* Doppler effect.

Now, on the basis that the incident photon starts to be reflected at the same time when it 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 (and this means 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 (53), is

$$p' = m'c = \gamma\nu'c = \gamma c/T' \tag{118}$$

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 \mathbf{w} , becomes

$$\gamma c/T' \sin \theta = \gamma c/T \sin \theta' \tag{119}$$

giving $\theta = \theta'$. Then, the length of the reflected photon, for the Observer A, see (17), is

$$\lambda' = \lambda + \Delta\lambda \tag{120}$$

where $\Delta\lambda = w_A T'$, 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

$$\lambda' - \lambda \equiv \Delta\lambda = w T' \cos \theta \tag{121}$$

Now the CoM along \mathbf{w} , being $\theta = \theta'$, gives

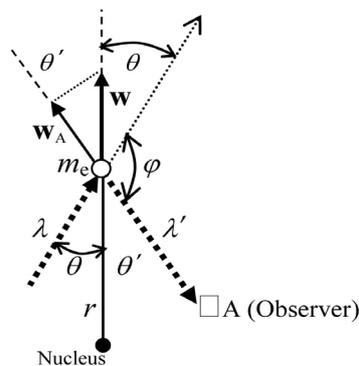


Figure 12. Compton effect (CE). φ : angle between the direction of the incident photon and the scattered one (λ'); θ : angle between the direction of the incident photon and the recoiled electron.

$$\frac{\gamma c \cos \theta}{T'} + \frac{\gamma c \cos \theta}{T'} = m_e w \Rightarrow w T' = (2\gamma c \cos \theta) / m_e \quad (122)$$

so the (121) becomes

$$\lambda' - \lambda (\equiv \Delta\lambda) = \frac{2\gamma c \cos^2 \theta}{m_e} = \frac{2h \cos^2 \theta}{cm_e} \quad (123)$$

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

$$\Delta\lambda = 2h \sin^2 \left(\frac{\varphi}{2} \right) / cm_e \quad (124)$$

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

$$\Delta\lambda = \lambda' - \lambda = h(1 - \cos \varphi) / cm_e \quad (125)$$

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

We point out that the (122) written as $w = (2\gamma v' c \cos \theta) / m_e$, for $\cos \theta = 1$ equals the (85), implying the impact of **one photon** only.

Now, the (123), for $\cos \theta = 1$ gives $\lambda' = \frac{c}{\nu} + \frac{2\gamma c}{m_e}$ we can write as:

$$T' = \frac{1}{\nu} + \frac{2\gamma}{m_e} = (m_e + 2\gamma\nu) / \nu m_e \quad (126)$$

which plugged into (122) gives

$$w = \left(\frac{2\gamma c}{m_e} \right) / (m_e + 2\gamma\nu) / \nu m_e = \frac{2\gamma\nu c}{2\gamma\nu + m_e} = \frac{c}{1 + m_e / 2\gamma\nu} \quad (127)$$

yielding $w \rightarrow c$ for $\nu \rightarrow \infty$.

3. Conclusions

This paper is mainly based on three conditions: $c = u$ (with u the *total* escape speed); a certain structure of the light (massive photons having variable length); the electron charge like a point-particle facing the atom nucleus during the electron orbit.

On these bases, we gave a *classical* reason to the apparent constancy of c , then we showed that the *time dilation* turns out to be an effect of the variation of the *total* gravitational potential U (inducing a variation of c) and we also showed that the high gravitational red shifts are also due to the same reason; we also showed that the quantum numbers are nothing else than the numbers of photons admitted on free atoms along an integer number of electron orbits; then we gave a reason why the circling electrons cannot fall into their nucleus, and we also showed that the ionization of free atoms happens when the electron radial speed (due to the impact photons-electron) equals the electron orbital speed.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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