Journal of Modern Physics, 2015, 6, 1343-1349
Published Online August 2015 in SciRes. http://www.scirp.org/journal/jmp
http://dx.doi.org/10.4236/jmp.2015.69139

A Feasible Experiment Contrary to the 2nd Postulate of SR

Alfredo Bacchieri

University of Bologna, Bologna, Italy
Email: abacchieri@libero.it

Received 7 July 2015; accepted 24 August 2015; published 27 August 2015

Abstract

Assuming the light as composed of *longitudinal-extended elastic* (*and massive*) *particles* emitted during an emission time *T* at speed *c* (=*u*) (with *u* the escape speed from all the masses, toward the infinity), it is shown that *c* is invariant (under the Newtonian mechanics laws), for an Observer fixed to the *initial* emission point E_p (the point where the emission starts), in spite of any motion of the source (of light) with respect to E_p. On the contrary, an Observer, in motion from E_p during the emission, will state (indirectly) a *Galilean* variation of *c* which can be proved and evaluated by an appropriate *feasible* experiment described here.

Keywords

Escape Speed toward the Infinity, Longitudinal-Extended Elastic Particles

1. Introduction

This paper, in accordance with the Newtonian laws, is based on following assumptions:

I. Gravity fields fixed to their related masses (*intending that each field is co-moving with its generating mass*).

II. Finite mass of the universe, *implying a finite value of U* (*total gravitational potential*) *and therefore of u escape speed toward the infinity due to all the masses in space*.

III. Light composed of longitudinal-extended elastic particles (*as defined in Section* 3) moving at speed $c = u$. *This equality is supported by a cosmological reason.*

On above bases (including, needless to say, Newton's absolute time and space) we obtain:

1) The relation $u = (-2U)^{1/2}$, where u is *total* escape speed, from all the masses, toward the infinity and U (*total* gravitational potential, due to all the masses in space), while the assumption $c = u$ (which implies the massiveness of the light and also $c_\infty \to 0$), gives to the speed of light a *cosmological*/*anthropic reason* to its value, as

How to cite this paper: Bacchieri, A. (2015) A Feasible Experiment Contrary to the 2nd Postulate of SR. *Journal of Modern Physics*, **6**, 1343-1349. http://dx.doi.org/10.4236/jmp.2015.69139

highlighted in Section 2.

2) The constancy of the speed of light, under the Newtonian laws, for an Observer fixed to the (initial) *emission point*, E_p, (the point where the emission of light starts), in spite of any motion of the source with respect to E_p.

3) A variation of c (in accordance with the Galileo's velocities composition law), if the Observer is in motion with respect to the said emission point (taken as reference frame): for instance, on Earth, an Observer in motion from the source (of light) fixed to the ground during the emission. This variation of c (contrary to the 2nd postulate of Special Relativity) can be proved by a feasible experiment described here.

2. *Total* Escape Speed, from All the Masses in Space

Here we get the escape speed due to one, two and n masses; then we assume $u = c$ $(= -2U)^{1/2}$, with u the *total* escape speed (from all the masses), and U the *total* gravitational potential .

As known, considering in space one only mass M (regarded as a point-like), the gravitational potential U acting on a particle having mass $m \ll M$, assuming $U_\infty = 0$, with s the distance M-m, is $U = -MG/s$ (this relation, according to our *first assumption* (*I*), is always valid in spite of any reciprocal motion between M and m). The related Conservation of Energy (CoE), $E = U + K$, where K $(= 1/2u^2)$ represents the unitary (for unit of mass) kinetic energy of our particle arriving from the infinity (where $u_\infty = 0$), for $E = 0$, gives $U = -K$, leading to

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

which is a scalar, (called *escape speed*), representing (in the considered point) the value of the velocity $\mathbf{u}$, any massive particle, under a potential U, needs to reach the infinity; thus $\mathbf{u}$ (*escape velocity*) has to be referred to M; if M is a real mass, $\mathbf{u}$ has to be referred to the point of M where $|U|$ has the max value, intending this point as the Centre of potential C_p. Therefore we have to write

$$\mathbf{v}_{C_p m} = \mathbf{u} \tag{2}$$

meaning that the escape velocity of our particle m has to be referred to C_p.

Considering now two masses M_1 and M_2, having, at a given time, distances s_1 and s_2 from a considered point, the potential $U_{1,2}$ in this point becomes

$$U_{1,2} \equiv U_1 + U_2 = -(M_1G/s_1) - (M_2G/s_2) \text{ J/kg}. \tag{3}$$

Without the assumption I, the Equation (3) is still valid, but $U_{1,2}$ could have a different value, depending on the *assigned* values of s_1 and s_2, at the considered time.

Now, the escape speed from two masses can be written

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

representing the value, in the considered point, of the (escape) velocity $\mathbf{u}_{1,2}$ which has to be referred to the Centre of potential C_p, (where $|U_{1,2}|$ has the max value).

Then, as $(2M_1G/s_1)^{1/2} = u_1$ and $M_u \cong 10^{53}$, we also get

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

therefore the escape speed due to all the n masses in space becomes

$$u = \sqrt{\sum u_n^2} = \sqrt{-2U} = \sqrt{\sum 2M_nG/s_n} \tag{6}$$

with $\sum M_n = M_u$ the universe mass, $U\left(= -\sum M_nG/s_n = -1/2\,u^2\right)$ the *total* gravitational potential in the considered point, where u (function of U) can be called *total* escape speed (toward the infinity), while the escape velocity $\mathbf{u}$ is referred to C_p (centre of potential of all the masses).

Now, considering as origin of our Reference frame, the *initial* position of m, we may call it Emission point E_p, (the point where m will be given the speed u), the following relation

$$\mathbf{v}_{E_p m} = \mathbf{u} \tag{7}$$

may be called as *relative* escape velocity of m from E_p, with $|\mathbf{u}| = \left(-2U_{(E_p)}\right)^{1/2}$.

The particle m, at the time of its emission, has, in general, a velocity $\mathbf{v}_{\mathrm{E_p}m}$ with respect to $\mathrm{E_p}$, hence, from $\mathrm{C_p}$, it has a velocity $\mathbf{v}_{\mathrm{C_p}m} = \mathbf{v}_{\mathrm{C_pE_p}} + \mathbf{v}_{\mathrm{E_p}m} = \mathbf{u} + \mathbf{v}_{\mathrm{C_pE_p}}$; thus if $\left|\mathbf{u} + \mathbf{v}_{\mathrm{C_pE_p}}\right| \geq u$ it turns out that m tends to the infinity: in particular, if the velocity $\mathbf{v}_{\mathrm{E_p}m}$ is provided to a great number of particles all around $\mathrm{E_p}$, more than half of them will surely tend to the infinity.

We assume now the equality $c = u$, hereafter supported by the estimated mass of the universe and also by this cosmological/anthropic reason: in fact, if $c < u$, all the masses in space, (having speed lower than u), will tend to a gravitational collapse, whereas for $c \geq u$, the mass of light, going toward the infinity in an unlimited time, tends to avoid the said collapse.

Here we also point out that the energy of light (mc^2) seems to be not in accordance with the said relation $E = U + K = 0$, where $K = 1/2mu^2$, but, as shown on [1], the energy of light is given by a kinetic energy $K = 1/2mc^2$, complying the said relation (plus an internal energy of the same value).

This following part of Section 2, is only a support to our assumption $c = u$.

The mass of universe, by some authors, is estimated [2]-[4] to be $M_u \cong 10^{53}$ kg; the same order of magnitude is given throughout the number ($\cong 10^{22}$) of observable stars [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, from the *Local Group* (LG) toward the infinity, like a function $\rho = \rho_c \mathrm{e}^{-as}$ with $\rho_c \cong 9.2 \times 10^{-27}$ kg/m^3 the *critical density* [7]. So the mass of universe can be written

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

yielding

$$a = \left(8\pi\rho_c / M_\mathrm{u}\right)^{\frac{1}{3}} \cong 1.3 \times 10^{-26} \text{ m}^{-1}. \quad (9)$$

From the LG, the variation of U, due to an increase of the distance ds, can be written as $\mathrm{d}U = -\mathrm{d}mG/s$ where $\mathrm{d}m = \rho 4\pi s^2 \mathrm{d}s$ with $\rho = \rho_c \mathrm{e}^{-as}$, hence the potential on Earth becomes

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

Now, according to Equation (6), on Earth it is

$$u_0 = \sqrt{-2U_0} \cong \sqrt{9 \times 10^{16}} \cong 3 \times 10^8 \text{ m/s} \quad (11)$$

Therefore, on Earth, $u_0 = c_0$, so that $1/2\, c_0^2 = -U_0$ and, in general we may argue

$$c = \sqrt{-2U} = u \quad (12)$$

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

3. Invariance of the *Total* Escape Speed *u* for a Particular Particle, Here Defined

Here it is shown that under the assumption III, should a source of *photons*, during their emission, move from its *initial* Emission point ($\mathrm{E_p}$), their length will vary, and since their *transit time*, (time to cross an Observer), will also vary, their speed becomes constant for any Observer fixed to $\mathrm{E_p}$, in spite of any motion source-$\mathrm{E_p}$.

The Galileo's velocities composition law, which is related to point-particles, cannot be, apparently, applied to a *particle* defined as follows:

"longitudinally-extended, elastic non divisible particle emitted at speed u by a source during an emission time T, and moving along rays, (continuous succession of *photons*)".

Of course, more *photons* emitted during an emission time T need an equal number of rays.

Calling *front* and *tail* the extremities of a *photon*, every *tail*, (along a ray free path), corresponds to the *front* of the next *photon*.

Now, on **Figure 1**, let S be a Source (of light), starting to emit, at $t = 0$, a *photon* (with *front* A) and let the *initial* Emission point $\mathrm{E_p}$ (the point where the emission starts), be the *origin of our reference frame*; then let S

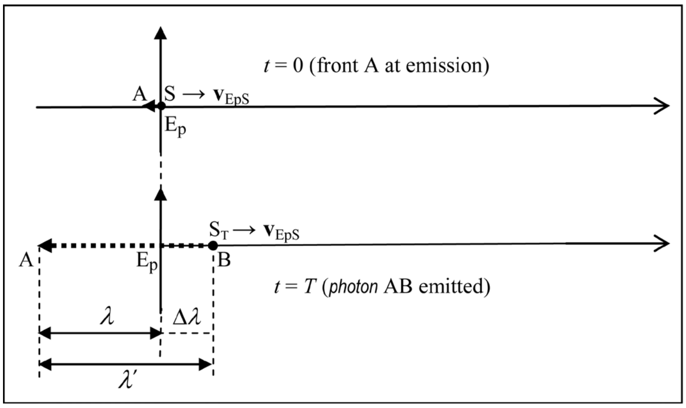


Figure 1. Emission of *photon* AB while the source S is in motion from the Emission point E_p.

move, during the emission time T, from E_p to S_T. For instance, E_p may be a generic point on the Earth's surface, with S coincident to E_p at $t = 0$.

Now, the *relative* escape velocity of the *front* A (being a point-particle), from Equation (7), can be written

$$\mathbf{v}_{E_pA} = \mathbf{u} \tag{13}$$

which gives, as hereafter shown, to the (whole) *photon*, for an Observer in E_p, (or fixed to it), a constant speed (u), in spite of any motion of S from E_p. At this purpose, still referring to **Figure 1**, let the source S have a velocity $\mathbf{v}_{E_pS}$ with respect to E_p; hence the velocity of the front A, with respect to S, that is, $\mathbf{v}_{SA}$, from Equation (13), becomes

$$\mathbf{v}_{SA} = \mathbf{v}_{SE_p} + \mathbf{v}_{E_pA} = \mathbf{u} - \mathbf{v}_{E_pS} \tag{14}$$

Therefore, at $t = T$, when S has reached the point S_T, we get

$$\boldsymbol{\lambda}' = \mathbf{v}_{SA}T = \left(\mathbf{u} - \mathbf{v}_{E_pS}\right)T = \boldsymbol{\lambda} - \mathbf{v}_{E_pS}T \tag{15}$$

where $\boldsymbol{\lambda}'$ is the *photon* AB emitted with the source in motion from E_p, while $\boldsymbol{\lambda}$ ($\equiv \mathbf{u}T$) should be the *photon* (AE_p) if S, during the emission, should be fixed to E_p.

Thus, after the emission time T, as for a source *receding* from the front A, as in **Figure 1**, the *photon* length λ', (for any Observer), from Equation (15), turns out to be

$$\lambda' = uT + v_{E_pS}T = \lambda + \Delta\lambda = \lambda(1+\beta) \tag{16}$$

where $v_{E_pS} = \left|\mathbf{v}_{E_pS}\right|$, where $\Delta\lambda\left(= v_{E_pS}T\right)$ is the path E_p-S_T covered by S during T, with $\beta = v_{E_pS}/u$, showing that the length of an emitted *photon*, for a given source, only depends on $\mathbf{v}_{E_pS}$.

Now, the speed of a *point-particle* is defined through two Observers, while the speed u' of a *photon*, (since its length could vary), does not correspond to the speed of any point of it, hence to define the speed of a *photon* we must consider its length referred to the time T' (*transit time*) the *photon* (front to tail) needs to cross one Observer, leading to

$$u' = \left|\boldsymbol{\lambda} - \mathbf{v}T\right|/T' = \lambda'/T' \tag{17}$$

which is the average speed of the *photon* along the path λ'.

As for this definition, let us consider a system composed of two balls connected through an elastic thread and let them fall in vertical line: during the fall, each part of the system has different speed, that is why we need the Equation (16) to define the speed of the *whole photon*.

Still returning to **Figure 1**, for an Observer fixed in E_p, the *transit time* T' of the *photon* AB 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-E_P $= \Delta\lambda\left(= v_{E_pS}T\right)$ which, (since the tail B is emitted by S, see Equation (13), at the same velocity $\mathbf{u}$ as the other parts of the *photon*), is $\Delta T = \Delta\lambda/u = v_{E_pS}T/u$, giving

$$T' = T + \Delta\lambda/u = T + v_{\mathrm{E_pS}}T/u = T(1+\beta) \quad \text{(Observer fixed to E}_\text{p}\text{)}. \tag{18}$$

Thus, see Equation (17), the speed of the *photon* AB, referred to our Observer fixed to E_p, becomes

$$u' = \lambda'/T' = \lambda(1+\beta)/T(1+\beta) = u \tag{19}$$

showing that, on our bases, an Observer, fixed to the Emission point E_p (point where the light starts to be emitted), states that the speed of light is invariant (and equal to the total escape speed), in spite of any speed Source-E_p.

Now, what about for an Observer in motion from E_p? Well, the length λ' of an emitted *photon* does not depend, see Equation (16) on the Observer motion, while the *photon* transit time T', depends, for an Observer fixed to E_p, see Equation (18), on $\mathbf{v}_{\mathrm{E_pS}}$ and it also depends, for an Observer in motion from E_p, on $\mathbf{v}_{\mathrm{E_pO}}$, leading, in short, to $T' = T(1 \pm v_{\mathrm{SO}}/u)$, where the sign ± is obviously given by the same/opposite direction Observer-source with respect to the one of the considered *photon*. For instance, if $v_{SO} = 0$ (Observer co-moving with S, both moving from E_p to S_T during the emission), the *photon* length, see Equation (16), is still λ', while its transit time (for the Observer and for S too) is $T' = T$, hence $u' = \lambda'/T \neq u$, that is $c' \neq c$.

Hereafter, to detect this variation, we describe a feasible experiment where the Observer (measuring the times), has to be in motion from the Emission point (taken as reference frame): usually, the measurements of c (through the method d/t), to be accurate, requires the Observer(s) to be fixed with the *photon* emission point), but, on our proposed experiment, the distance d, (variable during the experiment), is not involved into the evaluation of Δc.

4. Description of a Feasible Experiment Showing the Variation of the Speed of Light

To evaluate *our predicted* variation of c stated by an Observer O in motion from the *initial* Emission point E_p, we may assume, for simplicity, the source S fixed to E_p.

Thus, see **Figure 2(a)**, at $t = 0$ (start of emission), let O be located in E_p (our reference frame) and let $v_O = |\mathbf{v}_{\mathrm{E_pO}}|$ be the speed of O from E_p. So, at $t = 0$, it is: O and A_1 (front of the first emitted *photon*) both in E_p. At the end of the emission, lasting t_e (= nT), where n is the number of consecutive *photons* (A_1B_1-A_nB_n), the path covered by the front A_1 becomes $L = n\lambda$, the Observer has covered the path $\Delta d = v_O t_e$, while the tail B_n is still in E_p. Then, when the tail B_n, at a certain time t_O, reaches O, the path covered by O is $\Delta L = v_O t_O$, where t_O corresponds to the (*transit*) time the n *photons* need to cross the Observer (that is from $t = 0$ to the time the tail B_n reaches O), hence we can write $t_O c = L + \Delta L$, so we get

$$t_O = (L + \Delta L)/c = (n\lambda + \Delta L)/c = nT + \Delta L/c = t_e + v_O t_O/c \tag{20}$$

giving

$$t_O = t_e/(1 - v_O/c) \tag{21}$$

which, for $v_O \ll c$, leads to

$$t_O \cong t_e(1 + v_O/c) \quad \text{(valid for } v_O \ll c\text{)} \tag{22}$$

and then

$$\Delta t \equiv t_O - t_e \cong t_e v_O/c \tag{23}$$

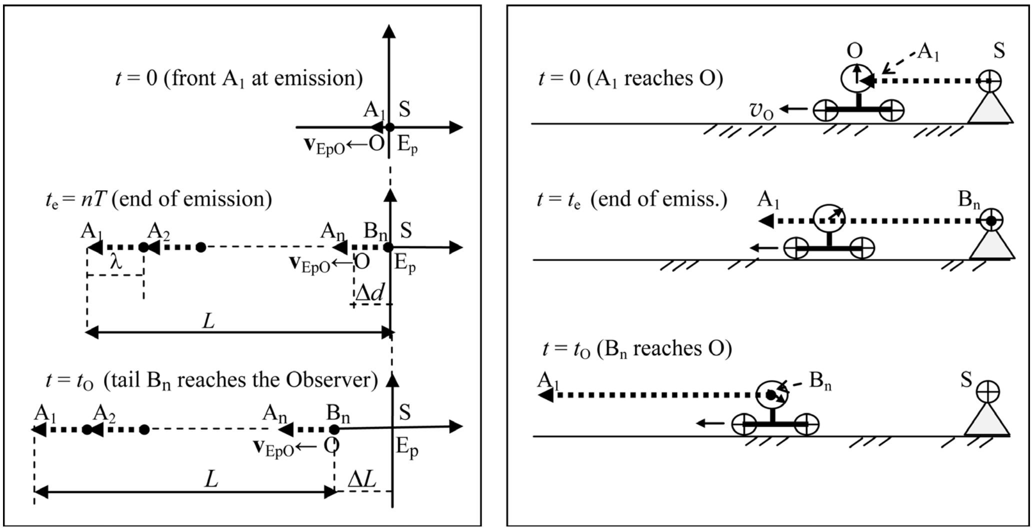
which is the variation of time stated by the Observer O between the transit time t_O and the emission time t_e where t_e is also the transit time for the Observer if this would be fixed to S. For instance, if $v_O = 10$ m/s and $t_e = 3$ s, one gets $\Delta t = 10^{-7}$ s, well measurable.

Therefore the speed of light as stated by the Observer O (moving along the same direction as the light) becomes

$$c' = L/t_O = n\lambda/\left[t_e/(1 - v_O/c)\right] = n\lambda(1 - v_O/c)/nT = c(1 - v_O/c) = c - v_O \tag{24}$$

while the speed stated by S (or by an Observer fixed to E_p) is: $c' = L/nT = n\lambda/nT = c$.

Referring to **Figure 2(b)**, where the source S and the Observer O are duly represented in a different position, as for the clock of the Observer we have:



(a) (b)

Figure 2. Schemes of a proposed experiment showing the variation of *c*. (a) Theoretical scheme; (b) Feasibility scheme.

$t = 0$ (start of times, when the first *photon*, A_1-B_1, reaches O);

$t = t_O$ (end of time, when the last *photon*, A_n-B_n, reaches O).

As for the clock of the source, not represented on figure (and not necessarily synchronized with the Observer clock), we have:

$t_S = 0$ (start of emission from S);

$t_S = t_e$ (end of emission).

We point out that the value Δt given by Equation (23) does not depend univocally on the speed of the Observer, hence the predicted (by the Relativity) time dilation due to the Observer motion, cannot be claimed.

Now for an Observer, the frequency of *photons* of the same ray has to be defined as $\nu = n/t$ with *n* the number of *photons* crossing the Observer during the time *t*; for $t = T'$ (generic *transit time* of one *photon*), it is $n = 1$, that is $\nu' = 1/T'$, therefore, from Equation (18), we get $\nu'(=1/T') = \nu(1 \pm \beta)$ with the sign + when source and Observer are approaching to each other; in fact, for O and S at reciprocal rest, the number of *photons* emitted by S in a unit time has to be equal, in the same time, to the number of them crossing O, and this implies $\nu_s = \nu_O$. Now we can summarize:

- if S is moving from E_p, (as in **Figure 1**), while the Observer is fixed to E_p, he will state: $c' = c$ and $\lambda' = \lambda(1+\beta)$, hence $T' = \lambda'/c' = T(1+\beta)$ and $\nu' = 1/T' = 1/T(1+\beta)$;
- if the Observer is moving from E_p along the same direction as the *photons* (like in **Figure 2(a)**), while S is fixed to E_p, the Observer will state: $c' = c - v_O = c(1-\beta)$, and $\lambda' = \lambda = cT$, hence $T' = \lambda'/c' = T/(1-\beta)$ and $\nu' = 1/T' = \nu(1-\beta)$.

5. Conclusion

We have seen that, on our bases, the speed of light (corresponding to the *total* escape speed) follows the Newtonian laws, and we have described a feasible experiment showing that the speed of light also follows the Galileo's velocities composition law, if applied to these *photons*.

References

[1] Bacchieri, A. (2014) *Journal of Modern Physics*, **5**, 884-899. http://dx.doi.org/10.4236/jmp.2014.59092

[2] Kragh, H. (1999) Cosmology and Controversy. Princeton University Press, Princeton, 212.

[3] Gogberashvili, M., *et al.* (2012) Cosmological Parameter. ArXiv:physics.gen-ph, 2.

[4] Immerman, N. (2001) Nat'l Solar Observatory: The Universe. University of Massachusetts, Massachusetts.

[5] Gott III, J.R., *et al*. (2005) *The Astrophysics Journal*, **624**, 463-484. http://dx.doi.org/10.1086/428890

[6] Van Dokkum, P. (2010) *Nature*, **468**, 940-942. http://dx.doi.org/10.1038/nature09578

[7] Schutz, B.F. (2003) Gravity from the Ground Up. Cambridge University Press, Cambridge, 361. http://dx.doi.org/10.1017/cbo9780511807800