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The Change of Light Speed due to Transformation from Micro to Macro Space

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Abstract:

A potential dependent special relativity under the transformation which preserves the momentum and the energy are used to find a new photon speed in a hyperspace. This speed is shown to exceed the speed of light for very small rest mass in the hyperspace and a larger radius of the hyperspace. The hyperspace is geometrically and algebraically different than the ordinary space; by which it doesn't depend on angles and lenses but rather considers the configuration of points and lines. The nature of the hyperspace which is constructed by axioms of projective geometry makes one see that the speed of light in the hyperspace can exceed that of the ordinary space. If the vacuum energy in the hyperspace is positive, the time interval is shorter and the distances are longer in the hyperspace. Using momentum uncertainty principle the photons' speed can be larger than the ordinary one if the photon is confined in a box from a hyperspace having certain positions. The same speed can also be obtained if the energy uncertainty principle is used provided that the photon was created due to nuclear transition and disappeared due to pair production when the life time of photon satisfies certain constraints.

Keywords: potential dependent special relativity, momentum, transformation, hyperspace, uncertainty principle.

Introduction:

The history of science starts from the existence of human life on the earth's surface, but the most spectacular one; which are well known as the corner stone of the modern science; are Newton's Laws [1]. These laws are well known to describe the motion of particles and astronomical objects in our universe [1], but unfortunately the famous experiment performed in 1887 by Michelson and Morley showed that the law of addition of velocities based on Newton's Laws are not valid for light, the experiment showed that the speed of light is constant and is not affected by the motion of the light source or the observer [2].

In 1905, Einstein proposed his special relativity (SR) theory to explain the behavior of light in the experiment [2], his theory is based on two postulates;

The first postulate states that all inertial frames of reference are equivalent, in the sense that the Laws of physics take the same form in all frames that move relative to each other with constant velocity [2].

The second postulate states that the speed of light is a universal constant, in the sense that it has the same value for all frames of reference [2]. Here in this research one can add restrictions for those two famous postulates. The first one is valid only in space of real plane with dimension 1 and complex plane with dimension 2 but not in complex plane of higher dimension such like quaternion and octonian. The second postulate is restricted by space time of four dimension but not necessary valid in hyperspace.

To find the SR Laws, he used Lorentz transformation [2]. This SR theory shows that the time, length and mass are velocity dependent, it succeeded in explaining a large number of physical phenomena including atomic fission, pair production, and mass decay [3], unfortunately SR failed to explain a number of observations like the change of electron mass when entering a crystal forming the so-called effective mass and the effect of gravity on time; the so-called time dilation cannot be explained by SR [4]. This motivated Mubarak Dirar to propose potential dependent SR (PSR) or the so-called generalized special relativity (GSR) to cure these defects [4]. It succeeded in explaining most of these phenomena [5].

Another extension of Newton's Laws were made to describe the micro world which consists of atoms and elementary particles. The behavior of the micro particles was shown to be different from that of ordinary visible particles, first by Max Plank; according to the Max Plank: the behavior of light in the black body radiation phenomena cannot be explained by treating light as waves, this encouraged Plank to propose that light behaves as a stream of discrete quanta (photons) or particles having energy proportional to the light frequency [2].

This postulate leads De Broglie to propose an inverse behavior; De Broglie proposed that particles like electrons behave as waves. This proposal was confirmed by Davisson and Germer in 1927. This particle-wave dual nature of the micro-world needs new mechanics. This new mechanical law was formulated by Schrödinger forming the so-called quantum mechanics [6]. The laws of quantum mechanics (QM) succeeded in explaining a large number of micro-world atomic phenomena, like atomic spectra, the band structure of semi-conductors [6]. These Laws show that the behavior and the laws that describe the atomic world are different in many respects from that used to describe our ordinary macro-world. For example; the uncertainty principle which shows that one cannot determine the momentum and position of atomic particles at the same time [6]. This means that if one determines the photon position precisely its momentum and thus speed can be infinite [6].

The classical Laws and Quantum Laws can be transformed to each other using Poisson brackets and commutators beside using correspondence principle [7] Not only does atomic world behave in a peculiar way but also some astronomical objects like black holes behave differently also [8].

The different laws that describe the behavior of different worlds or spaces motivates to try to use some special mathematical transformations based on general special relativity (GSR) [9] and Plank hypothesis beside uncertainty principle to prove that the speed of light can take different values for different spaces. This is done in Section (2). Section (3) is devoted for conclusion.

The speed of light in the hyperspace due to some transformations and discussion

The physical particle can make transformations from our ordinary space to a related hyperspace where the speed of light $\tilde{c}$, in it, exceeds that of c. Assuming that the momentum in the new space $\tilde{P}$ is preserved, meaning it is equal to the momentum in the ordinary space P. This requires defining the rest mass in the new space (hyperspace) $\widetilde{m_0}$ to satisfy the following transformation

$$f \rightarrow \tilde{f}$$

We can write preservation of the momentum in the two spaces in the form

$$\tilde{P} \rightarrow P$$

$$\widetilde{m_0}\tilde{c} = (m - m_0)\, c \tag{1}$$

In view of special relativity (sr) the mass is given by

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{2}$$

Where the rest mass in this space vanishes according to (sr), since

$$m = m_0 \tag{3}$$

Thus according to equations (3) and (1)

$$\widetilde{m_0} = (m_0 - m_0)\frac{c}{\tilde{c}} = 0 \tag{4}$$

However the situation is different for generalized special relativity (GSR);

The mass (m) of a particle in space (one call it hyperspace) where the vacuum energy does not vanish and equal to $\tilde{\varphi}$ is given by

$$m = \frac{m_0}{\sqrt{1 - {}^{2\tilde{\varphi}}/_{C^2} - {}^{\upsilon^2}/_{C2}}} \tag{5}$$

This can be rewritten

$$m = m_0(1 - 2\,\tilde{\varphi}/C^2 - {}^{\upsilon^2}/_{C2})^{-\frac{1}{2}} \tag{6}$$

Consider now the space transformation leads to change the vacuum energy from zero in the ordinary space to $\tilde{\varphi}$ in the new space (hyperspace). For weak field and zero velocity:

$\upsilon = 0$

$$2\,\tilde{\varphi}/C^2 << 1 \tag{7}$$

Thus equation (6) reduces to

$$m = m_0\left(1 - 2\,\tilde{\varphi}/C^2 - {}^{\upsilon^2}/_{C2}\right)^{-\frac{1}{2}} = m_0\left(1 + \left(-\frac{1}{2}\right)(2\,\varphi/C^2)\right)$$

$$m = m_0\,(1 + \tilde{\varphi}/C^2) \tag{8}$$

Thus inserting equation (8) in equation (1) yields:

$$\widetilde{m_0}\tilde{c} = \left[m_0 + \frac{m_0\tilde{\varphi}}{c^2} - m_0\right] \text{C} = \frac{m_0\tilde{\varphi}}{c^2}\, C \tag{9}$$

Thus the speed of light in the hyperspace becomes

$$\tilde{c} = \frac{m_0}{\widetilde{m_0}}\frac{\tilde{\varphi}}{c^2} C \tag{10}$$

Thus for the speed of light $\tilde{c}$ in the hyperspace to exceed that of the ordinary spaces c to make

$$\tilde{c} > c \tag{11}$$

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Equation (10) gives

$$\frac{m_0\tilde{\varphi}}{\widetilde{m_0}c^2} > 1 \tag{12}$$

$$m_0\tilde{\varphi} > \widetilde{m_0}c^2 \tag{13}$$

$$\widetilde{m_0} < \frac{m_0\tilde{\varphi}}{c^2} \tag{14}$$

Without rigorous proof; if one needs the speed of light $\tilde{c}$ to be the minimum multiple of one thousand of c due to the nature of the hyperspace which is composed naturally of multiples of thousands, i.e

$$\tilde{c} = 1000c \tag{15}$$

Equation (10) gives;

$$\frac{m_0\tilde{\varphi}}{\widetilde{m_0}c^2} = 1000$$

$$\widetilde{m_0} = \frac{m_0\tilde{\varphi}}{1000c^2} \tag{16}$$

To see how time and lengths looks like in the ordinary space and hyperspace , one have to assume that in the ordinary space vacuum energy vanishes (vacuum energy is negligibly small)

Since one assumes that in the hyperspace vacuum potential per unit mass is $\tilde{\varphi}$ and the rest mass is $\widetilde{m_0}$ thus the potential of the photon due to the vacuum effect takes the form

$$\tilde{v} = \widetilde{m_0}\tilde{\varphi} \tag{17}$$

If the photon frequency in the ordinary space is f and in the hyperspace is $\tilde{f}$ thus the photon energy in hyperspace is given by

$$h\tilde{f} = hf + \tilde{v} \tag{18}$$

Where the frequency f is related to the periodic time T and wave length λ according to the relation

$$\mathrm{f} = \frac{1}{T} = \frac{c}{\lambda}$$

$$\tilde{\mathrm{f}} = \frac{1}{\tilde{T}} = \frac{\tilde{c}}{\tilde{\lambda}} \qquad (19)$$

The relation between the time in the two spaces can be found using equation (17) and (19) to get

$$\mathrm{h}(\tilde{\mathrm{f}} - \mathrm{f}) = \tilde{v} \qquad (20)$$

$$h\left(\frac{1}{\tilde{T}} - \frac{1}{T}\right) = \tilde{v} = \widetilde{m_0}\tilde{\varphi} \qquad (21)$$

$$\frac{1}{\tilde{T}} = \frac{1}{T} + \frac{\tilde{v}}{h} \qquad (22)$$

Inserting equation (21) in (10)

$$\tilde{c} = \frac{m_0}{\widetilde{m_0}^2 c^2}\widetilde{m_0}\tilde{\varphi}c = \frac{\widetilde{m_0}\tilde{v}}{\widetilde{m_0}c^2}c \qquad (23)$$

$$\tilde{c} = \frac{m_0 h}{\widetilde{m_0}^2 c^2}\left(\frac{1}{\tilde{T}} - \frac{1}{T}\right)c \qquad (24)$$

For the speed of light in the hyperspace $\tilde{c}$ to exceed that of the ordinary space equation (4) should give

$$\tilde{c} > c$$

$$\frac{\tilde{c}}{c} > 1$$

$$\frac{m_0 h}{\widetilde{m_0}^2 c^2}\left(\frac{1}{\tilde{T}} - \frac{1}{T}\right) > 1$$

$$\frac{1}{\tilde{T}} > \frac{1}{T} + \frac{\widetilde{m_0}^2 c^2}{m_0 h} \qquad (25)$$

This requires the time in the hyperspace to be short, thus one second in the hyperspace is shorter than one second in the ordinary space.

The difference between the lengths in the two spaces can be found using equations (19), (20) and (10) to get

$$\tilde{c} = \frac{m_0}{\widetilde{m_0}^2 c^2}\widetilde{m_0}\tilde{\varphi}c = \frac{m_0}{\widetilde{m_0}^2 c^2}\tilde{\nu}c \qquad (26)$$

$$= \frac{m_0}{\widetilde{m_0}^2 c^2}h(\tilde{\mathfrak{f}} - \mathfrak{f})c = \frac{m_0 h}{\widetilde{m_0}^2 c^{\sim}}\left[\frac{\tilde{c}}{\tilde{\lambda}} - \frac{c}{\lambda}\right]c \qquad (27)$$

$$\left[1 - \frac{m_0 hc}{\lambda \widetilde{m_0}^2 c^2}\right]\tilde{c} = -\frac{m_0 h}{\widetilde{m_0}^2 c\lambda}c \qquad (28)$$

$$\frac{\tilde{c}}{c} = \frac{\left(\frac{m_0 hc}{\widetilde{m_0}^2 c^2}\right)\left(\frac{1}{\lambda}\right)}{\left[\frac{m_0 hc}{\widetilde{m_0}^2 \tilde{c}}\left(\frac{1}{\tilde{\lambda}}\right) - 1\right]} = \frac{\left(\frac{1}{\lambda}\right)}{\left(\frac{1}{\tilde{\lambda}} - \frac{\widetilde{m_0}^2 c^2}{m_0 hc}\right)} \qquad (29)$$

The speed of light in the hyperspace $\tilde{c}$ exceeds that of ordinary space when

$$\frac{\tilde{c}}{c} > 1 \qquad (30)$$

$$\frac{\left(\frac{1}{\lambda}\right)}{\left(\frac{1}{\tilde{\lambda}} - \frac{\widetilde{m_0}^2 c^2}{m_0 hc}\right)} > 1 \qquad (31)$$

$$\frac{1}{\lambda} > \frac{1}{\tilde{\lambda}} - \frac{\widetilde{m_0}^2 c^2}{m_0 h} \qquad (32)$$

$$\frac{1}{\lambda} + \frac{\widetilde{m_0}^2 c^2}{m_0 h} > \frac{1}{\tilde{\lambda}} \qquad (33)$$

$$\frac{1}{\tilde{\lambda}} < \frac{1}{\lambda} + \frac{\widetilde{m_0}^2 c}{m_0 h}$$

(34)

Thus the wave length in the hyperspace $\tilde{\lambda}$ should be larger than that in the ordinary space. This result is not like that of times in (25) which requires the time to be shorter. Thus the relation between space and time conforms to that of sr. The relation between the radius of the hyperspace and our earth-space r can be found, using Bohr model [2,6] which states that the circular orbit must consist of complete number (n) of waves, i.e.

$$\tilde{n}\tilde{\lambda} = 2\pi\tilde{r}$$

$$n\lambda = 2\pi r$$

(35)

Inserting equation (35) in equation (34) gives

$$\frac{\tilde{n}}{\tilde{r}} < \frac{n}{r} + \frac{2\pi\widetilde{m_0}^2 c}{m_0 h}$$

(36)

Assuming the numbers of waves are equal, one gets

$$\frac{1}{\tilde{r}} < \frac{1}{r} + 2\pi\frac{\widetilde{m_0}^2 c}{n m_0 h}$$

(37)

Transformation which preserves the momentum can be also tried instead of mass difference; one assumes the mass $\widetilde{m_0}$ in the hyperspace which is permeated by the vacuum energy$\tilde{\varphi}$ such that the momentum is preserved.

$$\widetilde{m_0}\tilde{c} = m_0 c$$

(38)

But the rest mass in the hyperspace permeated by vacuum energy per unit mass $\tilde{\varphi}$ when the particle is at rest $(v = 0)$is given by

$$\widetilde{m_0} = \frac{m^0}{\sqrt{1 + \frac{2\tilde{\varphi}}{c^2}}}$$

(39)

Inserting (39) in (38) gives

$$\frac{m_0}{\sqrt{1 + \frac{2\tilde{\varphi}}{c^2}}}\tilde{c} = m_0 c$$

(40)

Cancelling similar terms on both sides yields

$$\tilde{c} = \sqrt{1 + \frac{2\tilde{\varphi}}{c^2}}\ c$$

(41)

Thus the speed of light in the hyperspace $\tilde{c}$ exceeds that of the ordinary-space, when

$$\frac{\tilde{c}}{c} > 1$$

(42)

In view of (41), this requires

$$\sqrt{1 + \frac{2\tilde{\varphi}}{c^2}} > 1$$

(43)

Squaring both sides yields

$$1 + \frac{2\tilde{\varphi}}{c^2} > 1$$

(44)

This requires that

$$\frac{2\tilde{\varphi}}{c^2} > 0$$

(45)

$$\frac{2\widetilde{m_0}\tilde{\varphi}}{\widetilde{m_0}c^2} > 0$$

(46)

Using (17) yields

$$\frac{2\tilde{v}}{\widetilde{m_0}c^2} > 0$$

(47)

In view of equations (17) and (39), one gets

$$\tilde{v} = \tilde{m}\tilde{\varphi} = m\tilde{\varphi}/\sqrt{1 + \frac{2\tilde{\varphi}}{c^2}} \tag{48}$$

But equation (47) requires

$$\tilde{v} > 0 \tag{49}$$

With the help of equation (21), equation (49) gives

$$h\left(\frac{1}{\tilde{\tilde{T}}} - \frac{1}{T}\right) = \tilde{v} \tag{50}$$

Thus (49) and (50) requires

$$h\left(\frac{1}{\tilde{\tilde{T}}} - \frac{1}{T}\right) > 0 \tag{51}$$

Which means that;

$$\frac{1}{\tilde{\tilde{T}}} > \frac{1}{T} \tag{52}$$

Thus for the speed of light $\tilde{c}$ in the hyperspace to exceed that in the ordinary space, the time $\tilde{T}$ in the hyperspace should be smaller than the corresponding one in the ordinary space.

To see how the lengths are related in both spaces one uses equations (19) and (20) to get

$$h\left(\frac{\tilde{c}}{\tilde{\tilde{\lambda}}} - \frac{c}{\lambda}\right) = \tilde{v} \tag{53}$$

Using equation (59), yields

$$h\left(\frac{\tilde{c}}{\tilde{\tilde{\lambda}}} - \frac{c}{\lambda}\right) > 0 \tag{54}$$

Hence

$$\frac{\tilde{c}}{\tilde{\lambda}} > \frac{c}{\lambda} \tag{55}$$

Thus

$$\frac{\tilde{c}}{\tilde{\lambda}} > \frac{c}{\lambda} \tag{56}$$

Therefore

$$\frac{\tilde{c}}{c} > \frac{\tilde{\lambda}}{\lambda} \tag{57}$$

Hence the speed $\tilde{c}$ exceeds c ,I.e

$$\tilde{c} > c \tag{58}$$

When;

$$\frac{\tilde{\lambda}}{\lambda} > 1 \tag{59}$$

Which requires

$$\tilde{\lambda} > \lambda \tag{60}$$

Thus the hyperspace wave length $\tilde{\lambda}$ should be larger than that of the ordinary-space λ

Using Bohr's hypothesize again with $(\tilde{n} = n)$

$$n\tilde{\lambda} = 2\pi\tilde{r}$$

$$n\lambda = 2\pi r \tag{61}$$

Thus equation (60) requires

$$\tilde{r} > r \tag{62}$$

Which means that the radius $\tilde{r}$ of the hyperspace must exceed that of the ordinary space r

The plank energy relation can also be used. According to plank hypothesis quantum energy is given in term of the frequency, speed of light C and wavelength λ to be:

$$E = hf = \frac{hc}{\lambda} \tag{63}$$

In the macro world the energy can be expressed in terms of the new light speed $\tilde{c}$and new wave length $\tilde{\lambda}$ to be:

$$\tilde{E} = \frac{h\tilde{c}}{\tilde{\lambda}} \tag{64}$$

One considers the transformation which preserves energy. Assuming that the energy is conserved during the transformation yields:

$$\tilde{f} \to f$$

$$\tilde{E} = E \tag{65}$$

$$\frac{h\tilde{c}}{\tilde{\lambda}} = \frac{hc}{\lambda} \tag{66}$$

$$\tilde{c} = \frac{\tilde{\lambda}}{\lambda} c \tag{67}$$

Consider now Bohr's hypothesis where

$$n\lambda = 2\pi r$$

$$n\tilde{\lambda} = 2\pi\tilde{r} \tag{68}$$

Thus equations (67) and (68) give;

$$\tilde{c} = \frac{\tilde{r}}{r} c \tag{69}$$

Thus the speed of light in the hyperspace $\tilde{c}$ exceeds that in the ordinary-space when,

$$\frac{\tilde{c}}{c} > 1 \tag{70}$$

$$\frac{\tilde{r}}{r} > 1$$

$$\tilde{r} > r \tag{71}$$

This means that the radius of the hyperspace $\tilde{r}$ should be larger than that of the ordinary space, to see how the times look like one uses equations (19), (63) and (65) to get preserved in this transformation.

One uses uncertainty principle also to prove that in some cases the photon speed can exceed that of light by assuming that the photon mass is constant, while its speed changes. According to the uncertainty principle the change in the momentum ($\triangle p = m \triangle c$) and position ($\triangle x$) are related to each other according to the uncertainty relation to be

$$\triangle p \triangle x = h \tag{73}$$

$$m \triangle c \triangle x = h \tag{74}$$

$$m \triangle c = \frac{h}{\triangle x} \tag{75}$$

if the photon is confined to a box of size

$$\triangle x = \frac{h}{(mc)10^3} \tag{76}$$

Thus according to uncertainty principle

$$m \triangle c = (mc)10^3 \tag{77}$$

Thus deducting that the speed of light is

$$\triangle c = 10^3 \tag{78}$$

Thus the photon new speed is

$$\tilde{c} = c + \triangle c = (10^3 + 1)c \approx 10^3 c \tag{79}$$

This exceeds the ordinary speed in our world.

One can also use the uncertainty relation for energy and life time

$$\triangle E \triangle t = h \tag{80}$$

Where one assumes again the photon to have constant mass,

Thus

$$E = mc^2$$

(81)

$$\frac{\triangle E}{\triangle c} = 2mc$$

$$\triangle E = 2mc \triangle c \tag{82}$$

Inserting equation (82) in (81);

$$(2mc \triangle c) \triangle t = h$$

$$\triangle c = \frac{h}{2mc} \triangle t$$

(83)

If one assumes that a photon is created by a certain nucleus due to nuclear transition then after a time $\triangle t$ this photon decays by creating a pair of electron and positron, such that;

$$\triangle t = \frac{h}{2mc(10^3 c)} \tag{84}$$

Thus according to equation (83) and (84) one gets;

$$\triangle c = 10^3 c \tag{85}$$

Again the new speed of light is

$$\tilde{c} = c + \triangle c = (10^3 + 1)c \approx 10^3 c \tag{86}$$

Which exceeds the speed of light in our world

Discussion:

To find the new speed of light in the hyperspace, one assumes that the rest mass in this space is equal to the mass difference between the moving particle in a vacuum field and the mass in the free space as shown by equation (1). Here one treats the rest mass energy as vacuum background. One uses gsr and assumes momentum is constant under the momentum transformation as equation (1) shows. According to this transformation the new speed of light depends on the potential as well as the rest mass energy as equation (10) indicates the speed of light in the hyperspace exceeds the value c if the rest mass in it is beyond a critical value dependent on m_0, $\tilde{\varphi}$ and c, which represents the rest mass in the ordinary space, vacuum potential, and ordinary light speed respectively to see how time and dimensions look like, one study the behavior of a photon in ordinary and hyperspace respectively as shown by equations (20-22). Equation (25) and (37) show that the time should be short and the length should be long in the hyperspace.

The same result can be obtained by using a transformation based on gsr and preserves the rest mass momentum as shown in equations (38-40). The speed of light $\tilde{c}$ exceeds c if the vacuum energy is positive as shown by equation (49). Using the behavior of the photon in both spaces (52) shows that $\tilde{T}$ must be shorter than T, while $\tilde{r}$ should be longer than r as equation (62) indicates. Momentum uncertainty principle in equation (73) together with a special constraint on the photon location is used to determine the speed of light in the hyperspace. One assumes that the photon is confined to a box of a certain dimension given by equation (76). This constraint shows that the speed of light in the hyperspace can exceed that of the ordinary one. The same result can be obtained by using the uncertainty principle for energy in equation (80) beside assuming that the photon is created by a nuclear transition and destructed by pair production after a certain time determined by equation (84). This shows also that the speed of light in the hyperspace can exceed that of the ordinary one.

A third approach uses Plank hypothesis and preserving energy under coordinate and time transformation shows that the length $\tilde{r}$in the hyperspace should be longer while the time persists constant as shown by equations (71) and (72) respectively.

Conclusion:

Using gsr and transformation that preserve the momentum and the rest mass, it is possible to have space in which the speed of light exceeds that of ordinary vacuum. Plank hypothesis and uncertainty principle can also be used to get the same results. it is easy to prove mathematically that one could have different speeds of light. Different speeds of light come from considering dual space instead of absolute unique one. That dual space can preserve energy and momentum due to special transformation

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