Matter-light duality and speed greater than light

Shalender Singh*, Vishnu Priya Singh Parmar

Priza Technologies Inc. R&D, 1525 McCarthy Blvd, Ste 1111,

Milpitas, California, USA 95035

Ph: +1-408-466-8195, Fax: +1-408-825-2036

Email: shalender@prizatech.com

Abstract

In this paper we demonstrate duality between matter and light. Through mathematical derivation we show that every fundamental matter particle with non-zero rest mass can be represented by a photon pair. We use this duality to derive De Broglie wavelength. We show that a moving matter wave has 2 frequency components, one of it is with De-Broglie wavelength ***h/P*** and the other one is with wavelength ***hc/E***. We also correct the De-Broglie wavelength for ***v* = 0** where we show that there is only one frequency component for ***v* = 0** with wavelength ***hc/E***. Later in the paper we show that space-time transformation is a combination of two light waves indicating a strong correlation of space-time and matter-light. It also indicates that the space-time is composed of light waves similar to Feynman's zero point energy.

We further derive that every photon can be represented by a non-zero rest mass particle pair, one going below the speed of light and the other going above the speed of light. We also derive and propose energy, momentum and **γ** functions for particles with speed greater than light. In the last part we use the **γ** of speed greater than light to redefine special relativity and Lorentz transformation for speed greater than light as a set of pure outcomes. This means that if there is an observer in the frame of reference **A**, which is at speed greater than light w.r.t. the frame of reference **B**, a single event in **B** will be observed a two different events in **A** and vice a versa.

Using these transformations we propose that a positron is an electron going at speed greater than light, which manifests as going into past.

Keywords: Matter light duality, Speed greater than light, Lorentz transformations, positron

1. Introduction

Matter and light have been considered as composed of two different kind of particles, matter has a non-zero rest mass and the light has zero rest mass. They are associated with different speeds; while the speed of light is always same in all frames of reference, matter/non-zero mass particles can never be accelerated to the speed of light [1]. Though both of these statements are correct, these do not rule out the possibility of quantum jumping particles from speeds less than light to speed greater than light.

Scientist worldwide have been struggling to break the speed of light barrier because the model of the fundamental particles is not complete. In this paper we propose a simpler and a more fundamental model with a few simple observations about the equations of energy and momentum. Using these observations we propose duality between matter and light and prove that this duality is consistent with the existing definition of energy and momentum.

In the section 2 we propose and validate the first part of the matter and light duality, which is that every non-zero rest mass particle can be represented by a photon pair. Using this result in sub-section 2.2 we prove that a matter wave is composed of two frequency components, one with the wavelength equal to De-Broglie wavelength $\lambda = h/P$ [1] and the other component with the wavelength $\lambda = hc/\mathrm{E}$.

In the section 3 we show that the duality also works well with the derivation of space-time, which suggests a deep relation between space-time and matter.

In the section 4 we propose and validate the second part of the duality; representation of a photon as non-zero mass particle pair with one particle with speed less than light and the other particle with speed greater than light. We further derive energy, momentum and γ for the particles with speed greater than light.

In the section 5 we extend the Lorentz transformation [2] and relativity [3] to speed greater than light, and we propose that the observations across speed greater than light is not one to one but are a set of "pure outcomes".

2. Particle with non-zero rest mass representation as a photon pair

Statement 1:

Let there be a non-zero rest mass particle **P**, stationary in an inertial frame of reference **B** and moving with a non-zero velocity $\vec{V}$ w.r.t. frame of reference **A**. Then **P** can be represented by a photon pair; first photon in the $\vec{V}$ direction and the second one in the $-\vec{V}$ direction in the frame of reference **A.** In the case of $\vec{V}=\vec{0}$, direction becomes singular, which means the photon pair can be assumed to be going in any direction with the first photon in exactly opposite direction of the second photon.

Proof by validation:

Validation of statement 1 for Energy and Momentum:

Let us take a pair of photons with frequency ω in reference frame **B.** If we take $\vec{n}$ as the unit vector in the direction of $\vec{V}$ then in frame of reference **B**:

Total energy of the photon pair in B is:

$$E_b = \hbar\omega + \hbar\omega = 2\hbar\omega \qquad \dots (1)$$

Total momentum of the photon pair in in B is:

$$\vec{P}_b = \hbar\vec{n}\omega / c - \hbar\vec{n}\omega / c = \vec{0} \qquad \dots (2)$$

Now let us consider the frame of reference **A.** In **A** the photons undergo Doppler shift as:

Energy of the away going photon in A is:

$$E_1 = \hbar\omega\sqrt{\frac{1-v/c}{1+v/c}}$$

Energy of the in-coming photon in A is:

$$E_2 = \hbar\omega\sqrt{\frac{1+v/c}{1-v/c}}$$

Where $\|\vec{V}\| = v$

Thus total energy of the photon pair in A is:

$$E_a = E_1 + E_2 = \hbar\omega\sqrt{\frac{1+v/c}{1-v/c}} + \hbar\omega\sqrt{\frac{1-v/c}{1+v/c}}$$

$$= \hbar\omega\left(\frac{1+v/\mathrm{c}+1-v/\mathrm{c}}{\sqrt{1-v^2/c^2}}\right) \qquad \ldots (3)$$

$$= 2\hbar\omega\left(\frac{1}{\sqrt{1-v^2/c^2}}\right)$$

From (2) & (3)

$$E_a = \frac{E_b}{\sqrt{1-v^2/c^2}} = \gamma E_b \qquad \ldots (4)$$

Similarly momentum in A is:

$$\vec{P}_a = \hbar\omega/c\sqrt{\frac{1+v/c}{1-v/c}}\vec{n} - \hbar\omega/c\sqrt{\frac{1-v/c}{1+v/c}}\vec{n}$$

$$= \hbar\omega/c\left(\frac{1+v/\mathrm{c}-1+v/\mathrm{c}}{\sqrt{1-v^2/c^2}}\right)\vec{n} \qquad \ldots (5)$$

$$= 2\hbar\omega\left(\frac{v/c^2}{\sqrt{1-v^2/c^2}}\right)\vec{n}$$

From (4) & (5)

$$\vec{P}_a = E_a/c^2\vec{V} = \gamma E_b/c^2\vec{V} \qquad \ldots (6)$$

Equations (4) and (6) are the equations of mass and momentum transformations for non-zero mass matter particle across frame of reference.

The above proves that the representation works well with the relativistic momentum and energy transformations. From the above we can define the relation of the rest mass of the particle and the photon frequencies as:

$$E_b = \hbar\omega + \hbar\omega = 2\hbar\omega = mc^2$$

$$\Rightarrow m = 2\hbar\omega/c^2 \qquad \ldots (7)$$

2.1 Derivation of De-Broglie wavelength

As we have shown in the proof of the statement 1 that non-zero mass particle can be represented by 2 photons, let assume the particle **P** matter wave equation is given by the sum of 2 light waves opposite direction, which means:

$$A_P = A_+ + A_-$$

As the frequency of A_+ wave is given by $\omega\sqrt{\frac{1+v/c}{1-v/c}}$ and of A_- wave is given by $\omega\sqrt{\frac{1-v/c}{1-v/c}}$ in the frame of reference **A,** the sum of them leads to 2 frequencies:

$$\omega_1 = \omega\left(\sqrt{\frac{1+v/c}{1-v/c}} + \sqrt{\frac{1-v/c}{1+v/c}}\right) = 2\gamma\omega \qquad \dots (8)$$

$$\omega_2 = \omega\left(\sqrt{\frac{1+v/c}{1-v/c}} - \sqrt{\frac{1-v/c}{1+v/c}}\right) = 2\gamma\omega v/c \qquad \dots (9)$$

Substitute ω from equation (7) in equation (13)

$$\omega_2 = 2\gamma\left(\frac{c^2 m}{2\hbar}\right) v/c$$

$$\Rightarrow \omega_2 = \frac{cmv\gamma}{\hbar}$$

$$\Rightarrow \omega_2 = \frac{c\left|\vec{P}\right|}{\hbar}$$

$$\Rightarrow \lambda_2 = 2\pi c/\omega_2 = \frac{2\pi\hbar c}{\left|\vec{P}\right| c} = \frac{h}{\left|\vec{P}\right|} \qquad \dots (10)$$

(10) is the De-Broglie wavelength.

In the above result we get another component ω_1 of the frequency as follows:

$$\omega_1 = 2\gamma\left(\frac{c^2 m}{2\hbar}\right)$$

$$\Rightarrow \omega_1 = \frac{cm\gamma}{\hbar} = \frac{E}{\hbar c}$$

$$\Rightarrow \lambda_1 = 2\pi c/\omega_1 = \frac{2\pi\hbar c}{E} = \frac{hc}{E} \qquad \dots (11)$$

2.3 Wavelength at speed 0

At speed = 0 there is a singularity in direction and there is only one component of matter wave with the wavelength $\lambda = hc/E$

3. Transformation of coordinates as Doppler shift of light

Statement 2:

If an inertial frame of reference **B** is moving with velocity $\vec{V}$ with respect to the frame of reference **A**, the transformation of coordinates can be represented by a Doppler stretch and compression of light waves, one in the $\vec{V}$ direction and the other in the $-\vec{V}$ direction

Proof:

For simplicity assume that both frames of reference **A, B** are at the origin at time = 0. Let us take $\vec{n}$ as unit vector in $\vec{V}$ direction.

3.1 For wave going away: If there is a light wave originating at ($\vec{0}$, 0) in both **A** and **B** going in the direction $\vec{n}$, away from the frame of reference **A,** the equation of the frontier of the waveform is given by:

$\vec{r}_b - \vec{n}ct_b = 0$ in the frame of reference **B**.

$\vec{r}_a - \vec{n}ct_a = 0$ in the frame of reference **A**.

If we look at the corresponding points $(\vec{r}_a, t_a) \to (\vec{r}_b, t_b)$ anywhere in waveform in **A** w.r.t. to **B,** the transformation due to Doppler stretch is given by:

$$\vec{r}_b - \vec{n}ct_b = \sqrt{\frac{1+v/c}{1-v/c}}(\vec{r}_a - \vec{n}ct_a) \qquad \dots (12)$$

3.2 For wave coming towards: If there is a light wave originating at ($\vec{0}$, 0) in both **A** and **B** going in the direction $-\vec{n}$, away from the frame of reference **A,** the equation of the frontier of the waveform is given by:

$\vec{r}_b + \vec{n}ct_b = 0$ in the frame of reference **B**.

$\vec{r}_a + \vec{n}ct_a = 0$ in the frame of reference **A**.

If we look at the corresponding points $(\vec{r}_a, t_a) \to (\vec{r}_b, t_b)$ anywhere in waveform in **A** w.r.t. to **B,** the transformation due to Doppler compression is given by:

$$\vec{r}_b + \vec{n}ct_b = \sqrt{\frac{1-v/c}{1+v/c}}(\vec{r}_a + \vec{n}ct_a) \qquad \dots (13)$$

Adding (12) & (13)

$$2\vec{r}_b = \sqrt{\frac{1-v/c}{1+v/c}}(\vec{r}_a + \vec{n}ct_a) + \sqrt{\frac{1+v/c}{1-v/c}}(\vec{r}_a - \vec{n}ct_a)$$

$$\Rightarrow 2\vec{r}_b = \vec{r}_a\left(\frac{1+v/\mathrm{c}+1-v/\mathrm{c}}{\sqrt{1-v^2/c^2}}\right) - \vec{n}ct_a\left(\frac{1+v/\mathrm{c}-1+v/\mathrm{c}}{\sqrt{1-v^2/c^2}}\right)$$

$$\Rightarrow \vec{r}_b = \vec{r}_a \left(\frac{1}{\sqrt{1-v^2/c^2}} \right) - \vec{n}ct_a \left(\frac{v/\mathrm{c}}{\sqrt{1-v^2/c^2}} \right)$$

$$\Rightarrow \vec{r}_b = \gamma(\vec{r}_a - \vec{n}vt_a) \qquad \ldots (14)$$

Similarly subtracting (12) from (13)

$$\vec{n}ct_b = \gamma(\vec{n}ct_a - v\vec{r}_a / c) \qquad \ldots (15)$$

The above equations are the relativistic transformation is of coordinates if $\vec{n}$ and $\vec{r}_a$ are in the same direction. A more generalized proof can be derived in the similar way.

4. Photon representation as two particles with non-zero rest mass:

Statement 3:

Any photon can be represented as a pair of non-zero rest mass particles, one going below the speed of light and the other going above the speed of light. If u is the speed of the non-zero mass particle below the speed of light in the opposite direction of photon, c^2/u is the speed of the other non-zero mass particle above the speed of light in the direction of photon.

Proof by validation:

4.1 Energy and momentum at speed greater than light:

We will derive the energy, momentum and γ of particle with $v > c$ assuming that the above statement is valid. We have worked out the 1D case for the sake of simplicity but it can also be easily extended to 3D.

4.2 Guessing energy, momentum and γ

Let us take a photo with frequency ω. Also let us take a pair of non-zero rest mass matter particles with speeds u and $v = c^2/u$. Let us assume that we do not know the energy and momentum functions for the particle above c but the speed of the particle still remain as following ratio: Pc^2/E. So:

$$E_u = mc^2 / \sqrt{1-u^2/c^2}$$

$P_u = -mu / \sqrt{1-u^2/c^2}$ (It is in the opposite direction of photon)

$E_{c^2/u} =$ Unknown energy function for $v > c$

$$P_{c^2/u} = E_{c^2/u} / c^2 \times c^2 / u$$

$$\Rightarrow P_{c^2/u} = E_{c^2/u} / u$$

So the total Energy and momentum is:

$$P = -mu / \sqrt{1-u^2/c^2} + E_{c^2/u} / u$$

$$E = mc^2 / \sqrt{1-u^2/c^2} + E_{c^2/u}$$

$E = Pc$ since addition of both non-zero particles make a photon

$$\Rightarrow mc^2 / \sqrt{1-u^2/c^2} + E_{c^2/u} = c\ (\ -mu / \sqrt{1-u^2/c^2} + E_{c^2/u} / u\ )$$

$$\Rightarrow E_{c^2/u}(1-c/u) = mc^2 / \sqrt{1-u^2/c^2}(1-u/c)$$

$$\Rightarrow E_{c^2/u} c/u \times (u/c-1) = mc^2 / \sqrt{1-u^2/c^2}(1-u/c)$$

$$\Rightarrow E_{c^2/u} = -mc^2 / \sqrt{1-u^2/c^2} \times u/c$$

$$\Rightarrow E_{c^2/u} = -mc^2 / \sqrt{c^2/u^2-1}$$

$As\ v = c^2/u$

$$\Rightarrow E_{v>c} = -mc^2 / \sqrt{v^2/c^2-1} \qquad \ldots (16)$$

Which is the function of energy for velocity $v > c$

Similarly

$$P_{v>c} = -mv / \sqrt{v^2/c^2-1} \qquad \ldots (17)$$

Which is the function of momentum for velocity $v > c$

From the above equations is we can take $\gamma_{v>c}$ as:

$$\gamma_{v>c} = -1 / \sqrt{v^2/c^2-1} \qquad \ldots (18)$$

4.3 Doppler Effect for $v > c$

Statement: If a particle going with speed $v > c$ emits a photon the Doppler Effect coefficient for the photon coming towards the observer is $D_{v>c(towards)} = -\sqrt{(v/c+1)/(v/c-1)}$ and for the photon going away from the observer is $D_{v>c(\text{away})} = \sqrt{(v/c-1)/(v/c+1)}$

4.4 Consistency of the statement (3.3) with (2) and equations (17) & (18)

As in the derivation in section (2):

$$E_a = E_1 + E_2 = -\hbar\omega\sqrt{\frac{v/c+1}{v/c-1}} + \hbar\omega\sqrt{\frac{v/c-1}{v/c+1}}$$
$$= -2\hbar\omega\left(\frac{1}{\sqrt{1-v^2/c^2}}\right) \qquad \ldots (19)$$

Substitute (7) in (19):

in the derivation in section (2):

$$E_a = -mc^2 / \sqrt{1 - v^2 / c^2}$$

Similarly for the momentum we can validate that:

$$P_a = -mv / \sqrt{1 - v^2 / c^2}$$

5. Modifying relativistic transformations for *v* > *c*:

For the purpose of simplicity we will work out our derivation for 1D. This is easily extensible for 3D. In the equation (18) we wrote $\gamma_{v>c}$ as $-1/\sqrt{v^2/c^2-1}$. For it to be consistent with the transformation of the coordinates we propose modification to the relativistic transformations. We change it from one to one correspondence of observations to a set of pure of outcomes.

5.1 Inconsistency of Lorentz transformation for *v* > *c*:

The Lorentz transformation of $v > c$ in 1D if a frame of reference **B** is moving at speed v w.r.t. **A** moving in +x direction is defined as:

$$\begin{aligned} x_b &= \gamma(x_a - vt_a) \\ t_b &= \gamma(t_a - x_a v / c) \end{aligned} \qquad \ldots (20)$$

For $\gamma_{v>c} = -1/\sqrt{v^2/c^2-1}$ as per the equation (20) the measurements made from **A** in **B** are not exactly same as measurements made from **B** in **A**. For example if there is a rod of length L in **A,** it is measured as length $-L/\sqrt{v^2/c^2-1}$ in **B.** But if there is a rod of length L in **B** it is measured as $L/\sqrt{v^2/c^2-1}$ in **A**.

Does it mean that particles cannot travel with speed greater than light? No, but it means that the transformations need to be extended to beyond the speed of light. For extending it beyond the speed of light we formulate that there are 2 set of observations for the same space-time point and vice-a-versa in the $v > c$ case.

The modified principle of relativity then is: The measurement set of "pure outcomes" is same if measurement is done from **A** into **B** and **B** into **A**. If the observations across $v > c$ is made, the observer will observe 2 co-existing outcome of the same measurement.

In the 1D case we re-define Lorentz transformations for $v > c$ as:

$$\begin{pmatrix} x_{b1} \\ ct_{b1} \\ x_{b2} \\ ct_{b2} \end{pmatrix} = 1/\sqrt{v^2/c^2-1} \begin{pmatrix} 0 & 0 & -1 & v/c \\ 0 & 0 & v/\mathrm{c} & -1 \\ 1 & -v/c & 0 & 0 \\ -v/c & 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} x_{a1} \\ ct_{a1} \\ x_{a2} \\ ct_{a2} \end{pmatrix}$$

If take $t_{a1} = t_{a2} = 0$ and if take rod of length L in **A** $x_{a1} = x_{a2} = L$ Then

$x_{b1} = -L / \sqrt{v^2 / c^2 - 1}$ and $x_{b2} = L / \sqrt{v^2 / c^2 - 1}$, which form a set of 2 pure outcomes from measurement of length in frame of reference **B** for a rod in frame of reference **A.**

6. Conclusion and Discussion

1. Representation of non-zero mass particles as a photon pair and vice a versa resolves and simplifies many derivation of space-time and quantum mechanics.
2. The representation leads to a new unification theory, which unifies space-time, matter and light in a very elegant way. We hazard to predict that Coulombs law and Maxwell equation can also be derived directly from the unification theory.
3. The extension of transformations beyond the speed of light also allows extending existing other physics beyond the speed of light.
4. Using the modified transformations we can prove that for speed greater than light an electron behaves like a positively charged particle going back in time, which is a positron

References

[1] L. d. Broglie, "Recherches sur la théorie des quanta (Researches on the quantum theory)," *Ann. Phys. (Paris)*, pp. 3, 22, 1924.

[2] H. Poincaré, "Sur la dynamique de l'électron (On the Dynamics of the Electron)," *Comptes Rendus*, vol. 140, pp. 1504 - 1508, 1905.

[3] N. D. Mermin, "It's About Time: Understanding Einstein's Relativity. Princeton University Press," Princeton University Press, 2005.

[4] R. P. Feynman, "The Theory of Positrons," *Physical Review*, vol. 76, no. 6, pp. 749-759, 1949.

[5] R. Feynman and . A. Hibbs, Quantum Mechanics and Path Integrals, New York: McGraw-Hil, 1965.

[6] S. Singh and V. P. Singh Parmar, "A method of creation of net useful energy by quantum tunneling of particles(fundamental like electrons or larger ones) from speed less than the speed of light to speed greater than the speed of light". Patent Under Process, 2013.