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Galilieo-Newtonian Relativity

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Abstract

The velocity $c = (\varepsilon_0 \mu_0)$ appears in Maxwell's equations, but these equations say nothing about that velocity with respect to an absolute background and give no reference frame against which that velocity is measured. All experimenters obtain the same values for ε_0 and μ_0, so the observed velocity is the same in any observer's reference frame. Since the speed of the moving observer can assume any value, the EM energy or wave leaving the source must have speed components in a continuous range, including *c* as measured in any arbitrary reference frame. The reference frame independent nature of Maxwell's equations does not prohibit a range of velocities, but instead dictates this to be so, and herein we develop a Galilean invariant form of Maxwell's equations. Thus, Maxwell's equations indicate there are physically detectable components of any EM energy that reach an observer faster or slower than a component traveling at *c* as measured by that observer. It is this peculiar nature of light that led to the development of special relativity, but it is shown that the Lorentz transformations are nothing more than an elegant manipulation of the Galilean transformations with no physical basis of support. A direct consequence of this demonstration is the possibility of superluminal communications and travel, such as may have been demonstrated with neutrinos at CERN.

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1. The Galilean-Lorentz Transforms

Maxwell showed that electromagnetic (EM) radiation travels as a transverse wave, and developed the equations in which appears the velocity *c*:

$$c \equiv \frac{1}{\sqrt{\varepsilon_0 \mu_0}}.$$

Maxwell's equations say nothing about this velocity with respect to an absolute background and give no reference frame against which it is measured. All experimenters, regardless of relative motion, obtain the same values for ε_0 and μ_0, so this velocity is the same for any observer with respect to their own reference frame.

In Figure 1, Alice moves to our right at *v*, with Bob stationary. Both see the flash from an event that occurred some distance to the right. Each measures the same value of ε_0 and μ_0, independent of their relative motion, and ascribes the same velocity, *c*, to light from the flash, independent of the source's relative motion.

Light moves from the source to Bob at *c* as measured in his frame, traveling a distance Δx in time $\Delta t = \Delta x/c$. Light travels from source to Alice at *c* as measured in her frame, traveling a distance $\Delta x'$ in time $\Delta t' = \Delta x'/c$, where primed and unprimed coordinates represent Alice's and Bob's reference frames respectively.

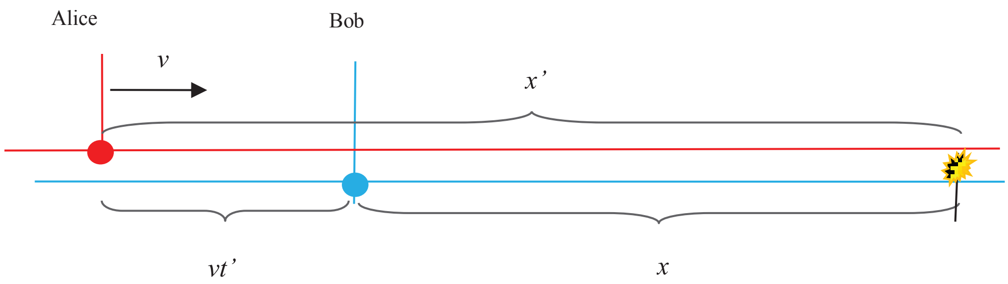

FIGURE 1. Observers in relative motion

Alice and Bob are at the origin of their respective frames. At $t = t' = 0$, the frames coincide and $x = x'$ for any *x*. At any other time, we have the Galilean relation:

$$x = x' + vt'.$$

For *t* < *0*, Alice is to Bob's left (vt' is negative). For *t* > *0*, Alice is to Bob's right. Relation (2) holds for any value of x' or t', but we are interested in the specific case of the time it takes light from an event to reach an observer.

We establish Alice momentarily next to Bob at the instant she sees the flash, at time $t' = t = 0$. Each carries a rod on which the flash leaves a mark measuring the distance to the event as x' for Alice and x for Bob.

Alice determines the flash occurred at:

$$t' = -\frac{x\prime}{c} \tag{3}$$

t' is negative since the flash occurred before being seen by Alice at $\mathrm{t}' = 0$. Inserting (3) into (2) gives the distance to the flash measured in Bob's reference frame:

$$x = x' + vt' = x'\left(1 - \frac{v}{c}\right). \tag{4}$$

Unremarkably, (4) reflects the Galilean transformations for one reference frame moving at a constant velocity with respect to another at a particular time $t\,'$ tand given x'. Recognizing the time it takes light to reach Bob in his reference frame as $t = -x/c$, and that the times of observation in the two frames are not simultaneous, rearranging the terms in (4) provides interesting results:

$$x' = \frac{x}{\left(1-\frac{v}{c}\right)} = \frac{x\left(1+\frac{v}{c}\right)}{\left(1-\frac{v^2}{c^2}\right)} = \gamma^2 x\left(1+\frac{v}{c}\right) = \gamma^2(x - vt), \tag{5}$$

where we define:

$$\gamma \equiv 1/\sqrt{1 - v^2/c^2}. \tag{6}$$

Recalling that $t = -x/c$, dividing through by $-c$ in (5) provides the relation between the times of the flash determined in each reference frame:

$$\mathrm{t}' = -\frac{x'}{c} = \gamma^2\left(\frac{-x}{c} + \frac{vt}{c}\right) = \gamma^2\left(t - \frac{vx}{c^2}\right). \tag{7}$$

We multiply both sides of (5) by γ^{-1} to define a contracted length of Alice's rod as:

$$\overline{x'} = \frac{x'}{\gamma} = \gamma(x - vt), \tag{8}$$

We multiply both sides of (7) by γ^{-1} to define a dilated time in Alice's frame as:

$$\overline{t'} = \frac{t\prime}{\gamma} = -\frac{x'}{c\gamma} = \gamma\left(t - \frac{vx}{c^2}\right) \tag{9}$$

Multiplying through by γ^{-1} doesn't alter the validity of the equations at all. Beginning with the Galilean transform (2), we have simply rearranged terms to derive the relativistic Lorentz transformations for motion along the x-axis, and we will call them the Galilean-Lorentz transforms.

The Galilean-Lorentz transforms are simply a rearrangement of the observations of light propagation in a strictly Galilean framework. One must be careful about their meaning. They are a way to derive elapsed time and distance travelled from emission to detection by one observer from elapsed time and distance travelled from emission to detection by a relatively moving observer. The simplest and most useful form is seen in Maxwell's light speed equation (1) combined with the Galilean transform (2), but casting them in this form provides insight into the special theory of relativity. As we will see, these equations have nothing to say about time dilation and length contraction without unjustified assumptions.

Let's confirm what these equations actually say. The flash occurred at x' and x in Alice and Bob's reference frames respectively. The elapsed time from emission to observation by Alice is $t' = x'/c$, and for Bob is $t = x/c$. Alice is a distance x' from the source of the flash. Multiplying through by $c\gamma$ in (9) yields:

$$-x' = \gamma^2\left(ct - \frac{vx}{c}\right) = \frac{\left(-x-\frac{vx}{c}\right)}{\left(1-\frac{v^2}{c^2}\right)} = \frac{-x\left(1+\frac{v}{c}\right)}{\left(1-\frac{v}{c}\right)\left(1+\frac{v}{c}\right)} = \frac{-x}{\left(1-\frac{v}{c}\right)}. \quad (11)$$

Multipling through by $-(1 - v/c)$ and using $t' = -x'/c$ in (11) gives:

$$x = x'\left(1 - \frac{v}{c}\right) = x' - \frac{vx'}{c} = x' + vt'. \quad (12)$$

Dividing x by c yields the elapsed time from flash to observation in Bob's reference frame:

$$t = \frac{x}{c}. \quad (13)$$

(12) and (13) are the relations under which we established the problem, confirming that the Galilean-Lorentz equations (8) and (9) are simply a restatement of (1) and (2).

Bob sees the flash before Alice, and the time difference between observations is:

$$|t-t'| = \frac{x}{c} - \frac{x'}{c} = \frac{x'+vt'-x'}{c} = \frac{vt'}{c}. \quad (14)$$

Recalling that Alice saw the flash at $t_A = 0$, she claims the event occurred at $t_f = -x'/c$. From (14), Bob saw the flash at $t_B = t_A - vt'/c = -vt'/c$. For Bob, the flash occurred $-x/c$ earlier at:

$$t_f = \mathrm{t_B} - \frac{\mathrm{x}}{\mathrm{c}} = -\frac{vt'}{c} - \frac{x}{c} = -\frac{x'}{c}. \quad (15)$$

Thus Alice and Bob agree on the absolute time of the flash. The flash occurred at distance x in Bob's frame. At the time of the flash, Bob was $-vt'$ to Alice's right, so in Bob's frame the position of the flash was:

$$x = x' - (-vt') = x' + vt'. \quad (16)$$

Therefore, Alice and Bob also agree on the location of the event adjusted by the Galilean transform of position (2).

The importance of the above becomes apparent when we compare reference frames. The moving observer Alice saw the flash at time $t' = t = 0$. The stationary observer, Bob, was collocated with Alice at the time she saw the flash, but had already seen the flash at an earlier time.

An observer detects that component of EM radiation with a velocity of $c = 1/\sqrt{\varepsilon_0\mu_0}$ measured in that observer's reference frame. However, as we saw above when considering the stationary observer Bob, there are components of the EM wave from the source reaching his origin before and after the component he detected. These components are every bit as physically significant as that component detected by him, as demonstrated by Alice's detecting a different component at a later time while collocated with Bob.

Relatively moving observers momentarily collocated will not both see the flash from a distant event at that time. Special relatively *assumes* that collocated observers will each see the flash from an event at that time if either sees the flash at that time, and concludes that events simultaneous in one reference frame are not simultaneous in another reference frame. SRT takes the manipulated Galilean-Lorentz equations (8) and (9), and ascribes real meaning to the relations established and the value of γ derived [2]. The values $\overline{x'}$ and $\overline{t'}$ become the distance to and time since the event seen by the moving observer as measured in the lab frame. According to Bob, all lengths in Alice's frame along the direction of motion are shortened by $1/\gamma$ from the length it has in its rest frame (Alice's reference frame), and Alice's clocks are also slowed by the same $1/\gamma$ factor from the elapsed time measured in the rest frame. Since the measurement of length and time applies to anything to be measured or any method used to perform the measurement in Alice's frame, Bob concludes that the actual length dimension (in the direction of motion) and time itself have been altered by $1/\gamma$.

As an example, return to the figure and establish $v = .6c,\ x' = 10ls,\ t' = 10sec.$ From (2), we have:

$$x = x' + vt' = 10 + .6(-10) = 4ls \tag{17}$$

Now, according to Bob, using (17):

$$\overline{x'} = \gamma(x - vt) = 1.25[4 - .6(-4)] = 8ls, \tag{18}$$

And, using (18):

$$\overline{t'} = \gamma\left(t - \frac{vx}{c^2}\right) = 1.25[-4 - .6(4)] = -8sec. \tag{19}$$

The 10*ls* measured by Alice is only 8*ls* as measured in Bob's frame. Bob explains that she must subtract from the length of her rod the distance she travelled in the time since the event (10*s*), or 6*ls*, thus, in Bob's frame, she will be 4*ls* away from the event at the time she sees it, which is precisely how far away Bob is – Bob and Alice both see the flash at the same time.

Since special relativity uses the correct Galilean-Lorentz transformation equations, one obtains self-consistent solutions in whatever particular reference frame one chooses. Unfortunately, the underlying physical assumptions are baseless, leading to the untenable conclusion that when in motion, all of space and all of time is distorted. This distortion occurs for all motion, of any and all objects, moving in any and all orientations, throughout all of space and time. Any practical consideration of this should lead one to conclude that special relativistic transforms represent only a mathematical generalization, not an actual physical alteration of space and time due to the relative motions of various observers.

In the particular case of the Galilean-Lorentz transforms, since special relativity uses $\overline{x'} = x'/\gamma$ in place of x', an extraneous length contraction factor of $1/\gamma$ is applied as a separate correction to observations allegedly made in the moving reference frame to recover the initial Galilean transform. The combination of special relativity's Minkowski-Lorentz transform, combined with the proper length and time adjustments, recovers the full Galilean-Lorentz transform, which we have shown is nothing more than Maxwell's light speed equation (1) applied in a purely Galilean framework (2).

The Galilean transform can be arranged in such a way as to produce the special relativistic transforms. Since all measurements must ultimately be transformed to the reference frame of the observer, the conceptual error in special relativity cannot be readily detected and all results are by default consistent with observation. Consequently, every derivation of special relativity (i.e. form invariance in Maxwell's equations as we show) can also be derived in a purely Galilean framework.

Having seen that ascribing real meaning to the arbitrarily derived factor, γ, is an error, we must also conclude that the concepts of length contraction and time dilation are in error, and, as a result, the derivation of *c* as a maximum attainable velocity is also in error. Consequently, the neutrinos at CERN arriving 60 nanoseconds earlier than a light signal travelling the same distance are not violating any laws of physics, but are instead illuminating the arbitrary and unfounded assumptions of the special theory.

2. Galilean Invariance of Maxwell's Equation

One considers three quantities, length, time and the speed of electromagnetic (EM) propagation in transforming Maxwell's equations between reference frames. Einstein assumed the velocity of EM propagation to be strictly *c*, requiring the Lorentz transformations to keep the form of Maxwell's equations consistent. This was at the expense of standard concepts of length, time, and simultaneity; each becoming distorted to accommodate the constancy of *c*. But if we assume as in the previous section that it is only the measured speed of light observed in any reference frame that is *c*, then we are free from the Lorentz transforms.

In figure 1, observers in the stationary (K) and moving (K') frames are at the origins S and S' respectively. The origins are initially coincident at the time of a flash at A, a distance *x* from S. The component velocity of light in the non-moving K frame is *c*. As measured in the K' frame (moving with a constant velocity *v*), $c' = c$, but in the K frame c' is $c + v$. Restricting motion of the K' frame to the x axis, the Galilean transformations become:

$$x' = x + vt\,; \qquad y' = y\,; \qquad z' = z\,; \qquad t' = t \tag{20}$$

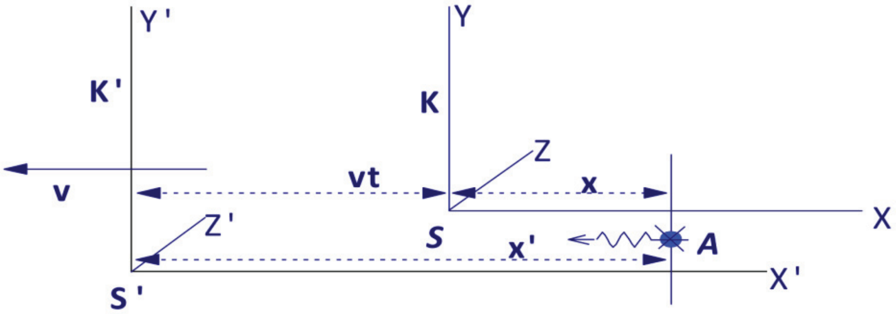

FIGURE 2. Stationary K and moving K' frames

From a treatment of wave mechanics, for wave propagation in the *x* direction with $E_Z = 0$ and *c* the velocity of propagation, we write:

$$\frac{1}{c^2}\frac{\partial^2 E_y}{\partial t^2} = \frac{\partial^2 E_y}{\partial x^2} \tag{21}$$

If a flash of light occurs some distance *x* from the origin of *K*, we can let *x* be represented by *c* times the time it takes light to reach an observer at *K's* origin. Thus, we derive the following relations:

$$x = ct; \qquad x' = x + vt = \alpha x; \qquad \alpha = (c + v)/c \tag{22}$$

Combining equations (20) and (22), we obtain the following useful relations, where we can pull α out of the partial as a constant:

$$\frac{\partial}{\partial t'} = \frac{\partial}{\partial t}; \quad \frac{\partial}{\partial x'} = \frac{\partial}{\partial \alpha x} = \frac{\partial}{\alpha \partial x} \tag{23}$$

We can also derive two useful relations from (22), whereby we express ∂x in terms of ∂t and *c*, where the last expression holds since $t' = t$:

$$\partial x = c\partial t; \qquad \partial x' = \partial \alpha x = \alpha \partial x = \alpha c \partial t = c' \partial t = c' \partial t' \tag{24}$$

Now we wish to examine the wave equation for the same wave in the K' system. We have:

$$\frac{1}{c'^2}\frac{\partial^2 E_{y'}}{\partial t'^2} = \frac{\partial^2 E_{y'}}{\partial x'^2} \tag{25}$$

Substituting (23) into (25) and comparing with (21) yields:

$$\frac{1}{c'^2}\frac{\partial^2 E_y}{\partial t^2} = \frac{\partial^2 E_y}{\alpha^2 \partial x^2}\,, \quad or \quad \frac{\alpha^2}{c'^2}\frac{\partial^2 E_y}{\partial t^2} = \frac{\partial^2 E_y}{\partial x^2} \tag{26}$$

Comparing (26) with (21) implies:

$$\frac{\alpha^2}{c'^2} = \frac{1}{c^2}\,, \quad or \quad c' = \alpha c = \frac{c+v}{c} = c + v \tag{27}$$

Equations (26) and (27) demonstrate the frame invariance in going from the K frame to K', provided that the velocity observed in K', as measured in K, is $c + v$. This wave has a velocity as observed in K' of c, as required by experiment. The wave we are considering must have a velocity with respect to the source of c plus the velocity, v, of the K' system. Since v can assume any value, the light must leave the source in a continuum of velocities such that $0 \leq c \leq C$, where we place no arbitrary constraints on the upper bound of C.

One interesting consequence of the special relativistic Lorentz group is the invariance of the metric:

$$c^2dt'^2 - dx'^2 - dy'^2 - dz'^2 = c^2dt^2 - dx^2 - dy^2 - dz^2 \tag{28}$$

However, since c' is forced to transform into c under special relativity, the left side of equation (28) could simply begin with c'^2 and such a statement then holds under a Galilean transformation, where we use the substitution $dx = cdt$.

$$\begin{aligned} &c'^2dt'^2 - dx'^2 - dy'^2 - dz'^2 \\ &= (c^2dt^2 + 2vcdt^2 + v^2dt^2) - (dx^2 + 2vcdxdt + v^2dt^2) - dy^2 - dz^2 \\ &= c^2dt^2 - dx^2 - dy^2 - dz^2 \end{aligned} \tag{29}$$

Now we consider the transformation of Maxwell's equations to ensure that the assumed wave equation of (26) is actually valid. Maxwell's equations may be expressed as:

$$\nabla \cdot \mathbf{E} = 4\pi\rho, \quad \nabla \times \mathbf{E} = -\frac{1}{c}\frac{\partial \mathbf{B}}{\partial t} \tag{30}$$

$$\nabla \cdot \mathbf{B} = 0, \ \nabla \times \mathbf{H} = -\frac{1}{c}\frac{\partial \mathbf{D}}{\partial t} + \frac{4\pi}{c}\mathbf{J} \tag{31}$$

J is a vector quantity of current density, equal to the net amount of positive charge crossing a unit area of surface per second. Using the Galilean transformation, the transformation of **J'** is as follows:

$$\mathbf{J}' = \rho\mathbf{v}'\,, \quad J_{x'} = \rho v_{x'} = \rho\alpha v_x = \alpha J_x\,, \quad J_{y'} = J_y\,, \quad J_{z'} = J_z \tag{32}$$

All that remains is to show that primed equations in K' remain form invariant under the Galilean transformations of (1). We will demonstrate the transform for each quantity in turn, eliminating the trivial solutions (i.e. $E_z = E_x = B_y = B_x = 0$):

$$\frac{\partial E_{y'}}{\partial y'} = \frac{\partial E_y}{\partial y} = 4\pi\rho \tag{33}$$

$$\frac{\partial B_{z'}}{\partial z'} = \frac{\partial B_z}{\partial z} = 0 \tag{34}$$

$$\frac{\partial E_{y'}}{\partial x'} = -\frac{1}{c'}\frac{\partial B_{z'}}{\partial t'} \Rightarrow \frac{\partial E_y}{\alpha \partial x} = -\frac{1}{\alpha c}\frac{\partial B_z}{\partial t}, \quad or \quad -\frac{\partial E_y}{\partial x} = -\frac{1}{c}\frac{\partial B_z}{\partial t} \tag{35}$$

$$\frac{\partial B_{z'}}{\partial x'} = -\frac{1}{c'}\frac{\partial E_{y'}}{\partial t'} + \frac{4\pi}{c'}J_{y'} \Rightarrow \frac{\partial B_z}{\alpha \partial x} = -\frac{1}{\alpha c}\frac{\partial E_y}{\partial t} + \frac{4\pi}{\alpha c}J_y, \quad or \quad \frac{\partial B_z}{\partial x} = -\frac{1}{c}\frac{\partial E_y}{\partial t} + \frac{4\pi}{c}J_y \tag{36}$$

Thus, we see that Maxwell's equations are indeed form invariant under the Galilean transformation we have proposed. Next we will compare the wave as observed in the K' system with that observed in the K system. Further, the value c in the transformed equations is consistent for the observer in the K' system as required

3. The Doppler Shift

We can mathematically express the form of an EM wave propagating in the x direction by the following relations:

$$exp\{i(\omega t - kx)\} = exp\left\{i\left(\frac{2\pi c}{\lambda}t - \frac{2\pi}{\lambda}x\right)\right\} \tag{37}$$

With respect to the source, all velocity components of the EM wave must have the same frequency, thus the wavelength varies with the component velocity. We subscript the notation λ with the velocity of the component with respect to the source whenever we consider a wavelength. A simple relation exists between component velocity with respect to the source and the wavelength of that component, compared with the wavelength of the component leaving at c, as would be perceived by an observer stationary in K. With $c' = $ □c as before, this relation becomes:

$$\lambda_{c'} = c'/v = ac/v = a\lambda_c \tag{38}$$

From (37) and (38) we can express the wave equation for any velocity component c', as it appears with respect to the source, stationary in K, as follows:

$$exp\left\{i\left(\frac{2\pi c'}{\lambda_{c'}}t - \frac{2\pi}{\lambda_{c'}}x\right)\right\} \tag{39}$$

The wavelength in (39), $\lambda_{c'}$, will be the same under any transformation between inertial reference frames. The wavelength is simply a measure of length, such as a millimeter, and under a Galilean transformation, a millimeter in K' is the same as a millimeter in K. While distances, such as the distance of the origin of each system to an event, transform under equation (20), the definition of a given length, such as a ruler carried by each observer, will remain the same in each system under the Galilean transforms. To see how the wave of equation (39) appears to an observer in K' we replace t with t (since $t' = t$), x' with x, c' with c, and express $\lambda_{c'}$ as $\alpha\lambda$:

$$exp\left\{i\left(\frac{2\pi c'}{\lambda_{c'}}t - \frac{2\pi}{\lambda_{c'}}x\right)\right\} = exp\left\{i\left(\frac{2\pi c}{a\lambda}t - \frac{2\pi}{a\lambda}x\right)\right\} = exp\left\{i\left(\frac{1}{a}\omega t - \frac{1}{a}kx\right)\right\} \tag{40}$$

The wave number, k, the number of waves in 2π units of length, transforms to □$\pi/\lambda_{c'}$, as it should for an observed wavelength of $\lambda_{c'}$, and the frequency of the wave for the K' observer has been shifted to the red:

$$\upsilon' = 2\pi\omega/a = \upsilon/a = \upsilon c/(c+v) \tag{41}$$

The observed frequency in K' is the source frequency times the ratio of c (the observed velocity) to the component velocity as emitted in the source frame, K. The red-shifted frequency is also given by c over the wavelength observed in K', or $c/\lambda_{c'}$. Direct measurement of one way radial Doppler shift is problematic, with the best performance to date being the case of two-photon absorption in a moving neon gas. The nature of TPA lends itself to an adequate description under both a Galilean and special relativistic approach. Other direct tests of radial Doppler are not accurate enough to provide a distinction.

4. Aberration

We allow light to fall (instantaneously) perpendicular to an observer in a reference frame, K', moving with a velocity of v_y with respect to the source in K. The observer is located at a distance x as measured in K at the time of absorption. If the component velocity of light along the x-axis is c, the observer will not be sensitive to it, as the resultant of a velocity v_y and c_x is a value greater than c. For this reason, the velocity of the component of light to which the observer illustrated in figure 2 is sensitive, c', and the corresponding wavelength, are given by:

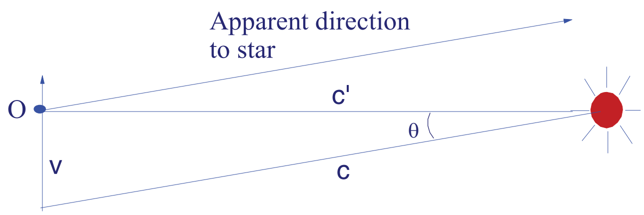

FIGURE 3. Perpendicular incidence on a moving observer

$$c' = \sqrt{c^2 - v^2} = c\sqrt{1 - v^2/c^2} = c\gamma^{-1}\,; \qquad \lambda' = \lambda\gamma^{-1} \tag{42}$$

The frequency of this light, expressed in K, is given by:

$$\omega = 2\pi c'/\lambda' \tag{43}$$

To obtain the frequency as observed in K', we simply replace c' with c, as we did in (40), and obtain:

$$\omega = \frac{2\pi c}{\lambda'} = \frac{2\pi c}{\lambda\gamma^{-1}} = \gamma\omega\,, \quad or \quad v' = \gamma v \tag{44}$$

Once again, we see that the observed frequency in K' is equal to the frequency of the source times the ratio of c (the observed velocity) to the initial velocity, c', where, from (42), $c/c' = \gamma$.

In figure 2, an observer in K' must look along the line given by the resultant of its velocity and the c' component traveling along the x-axis. This angle is easily clearly shown by the following:

$$sin\theta = v/c \tag{45}$$

An observer moving in a direction transverse to the line joining the earth to a star must tilt its telescope at the angle given by (45), consistent with experience.

5. Doppler Shift at an Arbitrary Angle of Incidence

In figure 4, the observer travels to the left at velocity, *v*, while a flash leaves the source, to strike the observer at the angle indicated. We calculate the component velocity with respect to the source that will strike the observer with a speed of *c* at the angle indicated. The Doppler shift is given by the ratio of *c* to this initial velocity as before. From the figure the initial velocity component of light leaving the source is given by:

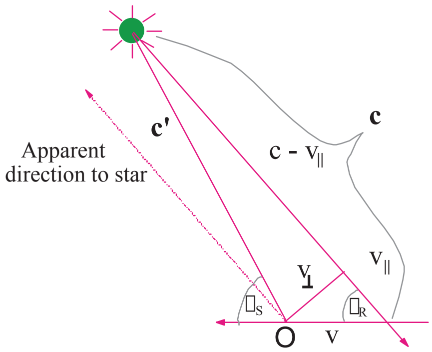

FIGURE 4. Arbitrary incidence on a moving observer

$$c' = \sqrt{(c - v_{\|})^2 + v_{\perp}^2} \tag{46}$$

Multiplying the source frequency times the ratio of *c* to the velocity of the component as measured in *K* gives the observed frequency:

$$\nu' = \frac{c}{\sqrt{\left(c-v_{\|}\right)^2 + v_{\perp}^2}}\nu = \left(1 + \frac{v^2}{c^2} - \frac{2v\cos\theta}{c}\right)^{-1/2} \tag{47}$$

The similarity between the SRT and Galilean formulas for Doppler is straightforward. The angle used in the Galilean approach is the apparent angle to the source as viewed by the observer, θ_G, while SRT uses the line joining source and observer, θ_S. We can relate these two angles as follows:

$$\cos\theta_G \approx \left(\cos\theta_s + \frac{v}{c}\right) \tag{48}$$

Substituting (48) into (47) and expanding, we derive a form of equation (47) dependent on the angle of SRT, where the last term is the relativistic Doppler equation for an arbitrary angle of incidence, and is accurate to within higher order terms in v^3/c^3 and above, which are ignored:

$$\frac{\nu'}{\nu} = \left(1 + \frac{v^2}{c^2} - \frac{2v\cos\theta_G}{c}\right)^{-1/2} \approx \gamma\left(1 + \frac{v}{c}\cos\theta_S\right) \tag{49}$$

6. Apparent Mass Increase in Particle Accelerators

We can use equation (50) to determine the force on a charged particle in a magnetic field of some fixed value **B**.

$$\mathbf{F} = q\mathbf{v}_o \times \mathbf{B} \tag{50}$$

However, the geometry of this equation as viewed from the laboratory frame is equivalent to that as viewed in the particle's frame only for small velocities $\mathbf{v}_o$, where the direction of **B** can be considered normal to the direction of $\mathbf{v}_o$. It is well known that the photon is the carrier of the electromagnetic force, and also that such forces must interact at a velocity of *c* with respect to the observer. We can therefore assign to the vector **B** a velocity component equal to *c*.

As the magnitude of $\mathbf{v}_o$ increases, the lines of the **B** field no longer appear normal to the direction of $\mathbf{v}_o$, in the reference frame of the particle, but instead are directed back along the hypotenuse of the triangle of figure 6. In the figure, the value of the cross product in equation (51) would be given by:

$$F' = q|\boldsymbol{v}_o \times \boldsymbol{B}| = qv_0 B cos\theta = qv_0 B\sqrt{c^2 - v^2}/c = qv_0 B\sqrt{1 - \frac{v^2}{c^2}} = F\gamma^{-1} \tag{60}$$

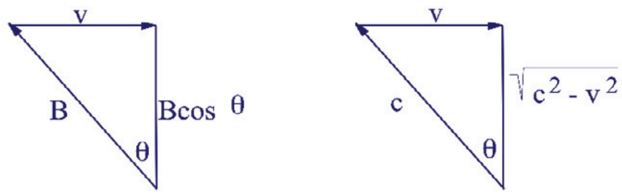

FIGURE 5. Aberrated B Field for a Moving Particle

In a particle accelerator, we wish to provide a constant acceleration to a particle of mass *m*, to keep it, say, confined to motion in a circle of defined radius. Referring to Newton:

$$a = F/m \tag{61}$$

Substituting (60) into (61) yields:

$$a' = \frac{qv_0 B}{m}\sqrt{1 - v^2/c^2} = \frac{F}{m}\gamma^{-1} = a\gamma^{-1} \tag{62}$$

Thus we see that, for a given **B** field, the effective acceleration of a fast moving particle, a', is given by the slow velocity acceleration, *a*, divided by γ. In SRT, no allowance is made for the reduction in force obtained by (60), and the following expression for the mass of the moving particle is obtained:

$$m = \frac{F}{a'} = \frac{F}{a}\gamma = m_0\gamma, \tag{63}$$

where m_o represents the so-called rest mass of the particle. Utilizing the obvious force reduction of (60), Galileo-Newtonian consideration produces the following expression for the mass of the moving particle:

$$m = \frac{F'}{a'} = \frac{F\gamma^{-1}}{a\gamma^{-1}} = \frac{F}{a} = m_0 \tag{64}$$

It is clear from this presentation that the preferred interpretation is that of a decrease in the effective force on the particle, and that the concept of mass increase with velocity is unnecessary.

7. Conclusion

One can describe the motion of light as observed within any given reference frame by use of the Galilean transform or the special relativistic Lorentz transform. While the latter provides no additional insight into the motion of light or its observation in various reference frames, it does arbitrarily and without basis impose an absolute upper limit of *c* on any motion or transfer of information. Possible implications of adopting the Galilean transform include the "superluminal" neutrinos observed by CERN, but also instantaneous remote communication of distant spacecraft or rovers, enhanced stealth technologies, communications with submarines at depth, and the ability to detect and track deeply submerged vehicles and objects, to name a few. For the very reason that neutrinos are able to travel faster than *c*, there is also no restriction on any massive object traveling faster than *c*, opening up the prospect for deep space travel by humans in realistic time frames.

One can extrapolate the results obtained above to demonstrate the slowing of clocks placed in motion or in gravitational fields, the deflection of light around a massive body, the perihelion shift of mercury, and apparent mass increase in particle accelerators, to name a few of the "tests" in support of relativity.

The Lorentz Transforms of special relativity create two problems associated with "faster-than-light" travel. The first is that the equations themselves prohibit event the possibility of exceeding the speed of *c*. This is not a limit such as the sound barrier, where it was once believed that matter might break apart at such speeds, it is a limit allegedly woven into the very fabric of space-time. The second problem is the alleged increase in mass as one approaches the speed of *c*. With increased mass comes increased energy requirements, making it impractical for any craft to carry or produce the power necessary to attain such speeds.

When one considers the Galileo-Newtonian Transforms presented herein, both of the limitations addressed above are removed. Attaining speeds that represent a substantial fraction of *c* simply require continual acceleration of even a modest scale. More importantly, continuing to accelerate even beyond *c* requires only the continued application of the same acceleration over time. It is certainly time that we begin to devote less time to confirming the equivalency of results of relativity to ever greater decimal places, and begin instead to establish experiments demonstrating the feasibility of communicating and traveling faster than *c*.