Relativity of the velocity of light

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Abstract: Despite consistent experimental evidence reaffirming the constant and universal maximum velocity of light, there remains some ambiguity with respect to the absolute certainty of this postulate. In particular, both cosmic inflation [A. R. Liddle and D. H. Lyth, *Cosmological Inflation and Large-Scale Structure* (Cambridge University Press, New York, 2000)] and quantum entanglement [A. Aspect, J. Dalibard, and G. Roger, Phys. Rev. Lett. **49**, 1804 (1982)] have been interpreted to demonstrate velocities in excess of the velocity of light. Although theories have been offered to explain these contradictions, there remains enough uncertainty to warrant further investigation. Here we will provide a new theory, using the principle of relativity, to offer both a framework for understanding this problem and a method for reconciling the ambiguity that arises from it. © *2012 Physics Essays Publication*. [DOI: 10.4006/0836-1398-25.1.62]

Résumé: Malgré l'évidence empirique affirmant la constance et l'universalité de la vélocité maximale de la lumière, il persiste une certaine ambiguïté en ce qui concerne la certitude absolue de ce postulat. En particulier, on a interprété l'inflation cosmique [A. R. Liddle and D. H. Lyth, *Cosmological Inflation and Large-Scale Structure* (Cambridge University Press, New York, NY, 2000)] et l'intrication quantique [A. Aspect, J. Dalibard, and G. Roger, Phys. Rev. Lett. **49**, 1804 (1982)] comme ayant des vitesses en excès de la vélocité de la lumière. Bien qu'on ait avancé des théories cherchant à expliquer ces contradictions, il reste toutefois suffisamment d'incertitude qui fait que la question mérite d'être approfondie. Dans le présent article, en nous servant des principes de la relativité, nous mettrons en évidence une nouvelle théorie qui offre un cadre pour mieux comprendre la question ainsi qu'une méthode qui permet de réconcilier l'ambiguïté qui en résulte.

Key words: Relativity of the Velocity of Light; Special Relativity; Light Velocity Is Relative to Gravitational Mass; Speed of Light Is Not Constant; Time; Relativity of Time

I. A PARADOX

We present the problem, to begin with, as a thought experiment.

As an imaginary construct, a thought experiment gives us license to imagine that an idea, however improbable, is physically realizable. In the initial section of this paper, it will be helpful to assume this frame of mind. For our purposes, the thought experiment contained herein is simply a visualization device. It serves to provide a reference point to the subject of this paper, which is that the velocity of light is a measurement relative to the mass environment in which it is taken.

To begin with, imagine that the entire expanse of the universe is contained in a transparent sphere the size of a soccer ball. Now imagine a man of proportional size relative to that soccer ball standing astride the ball. If this man shines a flashlight through the ball, we will imagine, for the sake of our thought experiment, that he observes the light traveling through it (near) instantaneously.

Now consider another man on the planet Earth *within* that soccer ball-sized universe. The same light from the flashlight of the man standing astride the ball will take billions of years to travel the expanse of the ball/universe from *his* perspective.

Under these terms, this thought experiment creates a paradox that we will address in a moment. In the meantime, it is necessary to set parameters to frame the rest of the discussion. We acknowledge two men. We recognize that these men are situated at fixed points. We establish that the men and their environment are proportionally identical so that the difference in mass (and size) between them exists at the same ratio as proposed for the two men in our thought experiment. (We will call them "large man" and "small man" going forward.) We further establish that the large man's environment is governed by the same physics (to scale) as the small man's environment, and that the large man is holding a flashlight of proportional mass and size. Finally, we state that both men perceive the velocity of light to be rendered by the following ratio:

$$V=\frac{D}{T}, \tag{1}$$

where V is the velocity of light, D is the distance traveled, and T is the elapsed time.

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With those arrangements made, let us return to the imaginary paradox. In accordance with special relativity, light should emerge from the flashlight of the large man at *299 792 458 m/1 s*.[1] If this is so, there is a false assumption in the thought experiment. The large man will not observe light moving through the ball (near) instantaneously; he will observe light (if he were to live long enough) moving at an excruciatingly slow speed. Like the small man, the large man would not see the light for billions of years.

The paradox, then, is that by the very act of moving to turn on the flashlight, the large man had *already exceeded* the velocity of light by several orders of magnitude. For our purposes, we will follow through with this imaginary paradoxical outcome and accept that light does not set a maximum universal velocity. With this suppositional acceptance in hand, there remains a series of steps necessary to recast the universal constant that we know as the velocity of light as a variable ratio realized at mass scale of any magnitude.

A. The velocity of light at mass scale

In Subsection I.A, we continue with the assumption that our paradoxical outcome is correct (that light does not set a maximum universal velocity) and follow it through to a logical (though still imaginary) resolution of the paradox.

As stated, velocity is perceived as a ratio. A ratio can only render a constant if changes in the numerator track changes in the denominator in exactly the same way. That is to say, in order to maintain a constant, the measurements of the velocity ratio must track each other as a measure of distance or time changes. We further state that the velocity ratio can be measured at different distances (or times) from a source of light. And because spacetime behaves geometrically, in order to measure different quantities of the velocity ratio, we will do so in *exponential* terms.

Now let us scale upward to the mass (and size) of the large man in our thought experiment. All else being equal, let us say that the large man is the same as the small man except that he has expanded, at scale, by the power of 10.

There now exist the imaginary circumstances necessary to reconcile the scenario in the thought experiment. By conjecturally scaling up our ratio by the power of 10, we get the following equation for the velocity of light:

$$V^{10}=\frac{D^{10}}{T^{10}}. \tag{2}$$

In this equation, the quantities remain fixed in relation to each other (in that they are adjusted in the same way) as is necessary to maintain a constant. However the velocity of light itself has increased by a substantial order of magnitude. In other words, the velocity of light that the large man observes covers the same distance and elapsed time at *exponential scale* that makes up the observation of the small man (if he were turning on a flashlight).

Under this scenario, there is no paradox at all. Both the large man and the small man would perceive the velocity of light as a constant, which in relative terms, is the same. But between them, in absolute terms, the velocity of light would vary. For general purposes, this equation could be rendered in the following way, with the velocity of light at scale varying according to the geometric expansion (or contraction) mandated by the variable exponents, where V is the velocity of light, D is the distance traveled, T is the elapsed time, and x is the variable scale exponent:

$$V^{x}=\frac{D^{x}}{T^{x}}. \tag{3}$$

B. Quantum effects of scale velocity

So how would this imaginary resolution of the paradox deal with the issue of quantum effects? Correlation at nonlocal distances is an example of phenomenon that can be interpreted to exceed the velocity of light on the quantum level. Observers have interpreted "entangled" actions to be instantaneous,[2] but scaled downward in our imaginary scenario, the action would take place at a great distance over a great period of time. Similarly scaled down, the velocity of light would undergo negative acceleration in accordance with the restrictions of the frame. Rendered with negative exponents, where V is the velocity of light, D is the distance traveled, and T is the elapsed time:

$$V^{-10}=\frac{D^{-10}}{T^{-10}}, \tag{4}$$

the velocity ratio remains constant, but the velocity of light, relative to our perspective, is reduced. Actions at this level that we observe as instantaneous are, at a relative scale, not instantaneous at all. In effect, by reversing scale downward, the small man becomes the large man. While the large man observes an effect that happens instantaneously, the small man, in this case an observer on the quantum level, sees a long process. The difference is a matter of relativity. Under our imagined scenario, this relative differential is responsible for the perception of simultaneity in quantum mechanics.

II. FROM PARADOX TO REALITY

We now step back to ground our imaginary reasoning in a real physical framework that will ultimately lead to a testable conclusion. We start with Eq. 1, where V is the velocity of light, D is the distance traveled, and T is the elapsed time:

$$V=\frac{D}{T}, \tag{5}$$

and we reiterate that the velocity of light is measured by a fixed ratio of distance traveled to time elapsed. We then move on to Eq. 3, where V is the velocity of light, D is the distance traveled, T is the elapsed time, and x is the variable scale exponent:

$$V^x = \frac{D^x}{T^x}, \tag{6}$$

which we affirm is *mathematically* correct. That is to say, under any pure mathematical circumstances, whatever action is performed on both parts of the ratio, must, by definition, be performed on its equivalent. We then offer this equation

$$V = \frac{D^x}{T^x}, \tag{7}$$

which represents the currently accepted reality of the velocity of light. At present, physics says that physical circumstances do not agree with pure mathematics. With respect to light, we say that any arbitrary exponential measurement of the distance traveled to elapsed time, in contradiction to the velocity ratio, equals an unchanging constant.

We are left with a *real* paradox. We have a physical truth that does not match the most basic mathematics necessary to describe the truth. To resolve this paradox, we posit that current theory is incomplete and that the velocity of light is subject to relativity of *mass scale*, with the difference between current orthodoxy and this hypothesis centered on the difference between arithmetic measurements of light and exponential measurements of light.

For example, if you say that the velocity of light is 3 m/1 s and you measure it arithmetically at a distance of 9 m from a light source, you would find that the velocity of light travels 9 m in 3 s. This measurement would maintain constancy (and is the present orthodoxy). But because spacetime behaves geometrically, another way to measure 9 m is as the square of 3 m. This calculation maintains the fixed velocity ratio, in that both sides can be squared, but the velocity of light would then be measured at an *inconstant* 9 m/1 s.

We propose that the inconsistency between these two methods of measurement is reconciled by fluctuations of mass concentration throughout the universe and, in particular, by the mass of the observer and his corollary mass frame of reference. The orthodox arithmetic method is accurate locally, *within* the mass frame of an observer, to a relatively high degree of precision, while the exponential method is, in reality, absolutely accurate *across* all mass frames (viewed superpositionally).

In other words, *within* the mass frame of an individual human, arithmetic works and the exponential formula is not particularly helpful (or accurate). But *across* the spectrum of mass concentration, the exponential formula produces acceleration of the velocity of light. In moving across concentrations of mass, then, the exponential formula is primary, and the arithmetic method is not particularly helpful (or accurate).

In essence, both measurements are correct. The arithmetic measurement works within a mass frame. The exponential measurement works between them.

If this is so, we can draw a correlation and direct proportion ($\propto$) between a change of a scale mass frame and the distance traveled (and, by fixed ratio, elapsed time) perceived as the velocity of light within that frame. This equation can be written as

$$O^X \propto \left(V^x = \frac{D^x}{T^x} \right), \tag{8}$$

where O is the mass frame of observer, V is the velocity of light, D is the distance traveled, T is the elapsed time, and x is the variable scale exponent, or more simply,

$$O \propto V. \tag{9}$$

Viewing the velocity of light in this way has the virtue of being unassailable from a mathematical point of view. Not only does it enable researchers to continue to observe the velocity of light as a very precise (though not absolute) fixed measurement at our mass scale, but it also enables the calculation of the velocity of light at other mass scales. In short, the velocity of light that we regard as a universal constant is, in reality, a *scale* constant.

A. Local time

The key to understanding the relativity of the velocity of light lies in distinguishing the local velocity of light—which is invariant within the mass frame defined by that velocity—from the far faster or slower velocities of light possible by exponential (nonlocal) scaling of the mass of an observer and their frame of reference.

What this means is that, locally, in the mass frame of a human being on the surface of the Earth, the equations we use to resolve the velocities of particles (i.e., relativistic addition of velocities, Lorentz, Minkowski *et al.*) continue to hold. That is to say, the measurements taken by human observers (or human technology) capture a "segment" of spacetime. Both the space and time captured during that measurement correlate specifically to the mass of observer and environment where and when the data was collected and nothing more. That data cannot be extrapolated in any absolute sense, but it *can* be used to make *gross* extrapolations that, given the minute differences of mass *surrounding* the human observer, act as very precise measurements.

To understand this, we think of time spatially. Returning to the logic of our thought experiment, we imagine our entire universe contained in a transparent sphere the size of a soccer ball. Putting yourself in the superposition of the large man, imagine that you can observe, within the ball, the chaotic wave flow of spacetime, as mass within the universe "warps" its environment. We will say that the more massive an area is, the redder it will appear. What would you see?

For starters, the entire sphere would be red. Within that redness, you would see clusters of darkness and areas of lightness that would be moving and changing in intensity of color. In essence, the inside of the sphere would be a swirling, waving chaos of shades of red.

It is those shades of red that represent time.

On the outside, from the viewpoint of the superpositional observer (the large man), the movements within the sphere take place from moment to moment, and the change is considerable. But inside, scaled down to an observer (the small man) on planet Earth, the limited redness that an observer could see would appear not to change at all. That observer, embedded in redness (indeed, red themselves), would experience the swirling, waving chaos much, much more slowly. For that person, time would be local and almost uniform in color.

In that frame, where mass is largely uniform, so too are the measurements of space and time. The achievements of classical physics are all built on this foundation.

B. Nonlocal time

Now imagine (you are still the large man) that the boundaries of the sphere disappear and its contents are absorbed into a much bigger sphere that contains the universe of the superpositional observer (you). To you, the mass of the universe in the original sphere simply blends into the surrounding mass of the superpositional sphere and becomes part of the uniformity of space and time. Here, again, is a local environment, which at the mass scale frame of the superpositional observer, is almost uniform in color.

But if we step back further to a superposition above the large man and the small man and compare the local, uniform mass frames of the two, we see that the uniformity of mass, space, and time that the large man perceives is exponentially larger than what the small man perceives. Across mass frames of reference, there is variance on an exponential scale.

Local and exponentially nonlocal environments, then, each have frames of reference that are *relatively* the same. But viewed from a third superposition, they are drastically different. This difference can be measured as the acceleration of the velocity of light.

C. Gravity and time

In view of this idea, given that it is hypothesized that at light speed time stops altogether, how can we "find the time" to allow for accelerated light? Putting aside questions of whether it is possible for time to stop and whether space can *exist* in stopped time, we theorize that the velocity of light represents, not a universal boundary, but the *scale boundary* of the *gravitational* mass frame where and when the measurement was taken. That is to say, an observer of a certain mass will exist within a surrounding framework of mass. The combined mass of observer and environment will produce a gravitational effect on spacetime.[3,4] That effect will also produce a specific corollary velocity of light for observation to an observer within that context. In sum, volumes of mass are embedded within larger volumes of mass. Volumes of space are embedded within in larger volumes of space. And volumes of time are embedded within larger volumes of time. Moving across these (flowing) volumes is where we "find the time" for light to accelerate.

Differences *between* mass frames (and the velocity of light observed therein) can then be calculated via exponential values beginning with the equivalence between the mass frame (gravitational force) on the surface of the Earth and the velocity of light measured there. In classical notation, the resulting equation is

$$\left(\frac{Gm}{r^2}\right)^x = c^x, \qquad (10)$$

where G is the gravitational constant, m is the mass of Earth, r is the radius of Earth, c is the speed of light, and x is the exponential variable. Under this formula, acceleration occurs as mass variance affects exponential change in the measurement of distance to time. Written as a ratio, the hypothesis demonstrates a relationship between gravity and electromagnetic radiation and gives us a metric for understanding a universe suffused with both

$$\frac{O^x}{V^x} = U^x, \qquad (11)$$

where O is the mass frame of observer, V is the velocity of light, and U is the gravitational/electromagnetic equivalence.

III. CONCLUSION

The theory of the relativity of the velocity of light states that the velocity of light is correlated to its specific frame of reference and that there are other frames of reference. As such, the velocity of light is determined not to be a universal constant but to be a scale constant. The theory states that gravitational mass is the correlative value coupled to the velocity of light at any given scale (including our own) and that, by using our frame of reference as a baseline, we can determine both the scale at which any given speed is the velocity of light and vice versa.

We hope that this paper will draw scrutiny and that its conclusions and implications will be examined thoroughly.

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