A New Perspective on the Relationship Between the Relativity Principle and the Laws of Mechanics

Richard O. Calkins
2125 Sahalee Drive East, Sammamish, WA 98074, USA
Email: rocalkins@msn.com

This paper explores the relationship between the relativity principle and the laws of mechanics. It does so by using a new experimental design which allows one to ask and answer questions which, apparently, have not previously been addressed.

1. First, the new design uses a physical reference frame to conduct the same experiment in one inertial reference frame and then move it intact to be repeated in another. That approach reaches outside the customary mental box of observations made by observers in inertial reference frames. The change in velocity takes place in a non-inertial reference frame. Einstein deferred addressing the effects of non-inertial motion to the general theory. But that is the only means by which an observer can take his experiment from one inertial reference frame to another. The recognition of that fact adds new information about the nature of inertial motion. It enables one to compare how the laws of mechanics treat the *change* in inertial velocity Δv, when an experiment is *moved* from one inertial reference frame to another, with how the relativity principle treats the resulting *difference* in velocity v_d between the same two reference frames. What this reveals is that the relativity principle does not conform to the laws of mechanics. Sometimes they agree, sometimes they do not. Why and how that happens reveals a new and fundamentally different relationship between them than the one which is generally accepted.
2. Second, the new design allows one to concurrently conduct two different kinds of experiment in the same physical reference frame both before and after it moves them from one inertial reference frame to another. One experiment involves the motion of a physical object. The other involves the propagation of a burst of light. This allows one to compare how the special theory treats an experiment using matter with how it treats an experiment using light under the same conditions of inertial motion. Again, surprisingly, the two are not the same. The examination of why that occurs reveals that the second postulate of relativity imposes a constraint on the burst of light which it does not impose on the physical object. By imposing a constant speed c on the burst of light, the second postulate makes it impossible for light to satisfy the first postulate. This is not a matter of opinion or of interpretation. As a simple matter of mathematics, it is not possible for something which has a fixed speed to respond to a change in its momentum in the same manner as do physical objects.

That, by itself, is enough to show that the special theory of relativity is invalid.

1. Introduction

The relativity principle is based on Galileo's observations of experiments involving the motion of physical objects.[1] Such motion is subject to the laws of mechanics.[2] Thus, it is generally accepted that the relativity principle is consistent with the laws of mechanics. Einstein's extension of the relativity principle to light requires light to behave consistently with the laws of mechanics, just as do physical objects.[3] That is the basis for believing that light will respond to momentum.

From his observations, Galileo determined that an experiment involving the motion of physical objects will produce the same *observed result* to a collocated observer in every inertial reference frame.[4] He also determined that the *observed* result will be different when the experiment is observed from a different inertial reference frame.[5] He reconciled the two outcomes in his relativity principle[6] by concluding that the *result* of an experiment will be the same in every inertial reference frame (the basis for the premise of equal merit) but is relative to the reference frame from which it is observed (the basis for the relativity of motion). As a result, Galileo's relativity principle defines an object's momentum P_{rp} as the product of its mass m and the difference in velocity v_d between the object and observer (P_{rp} = m v_d).[7]

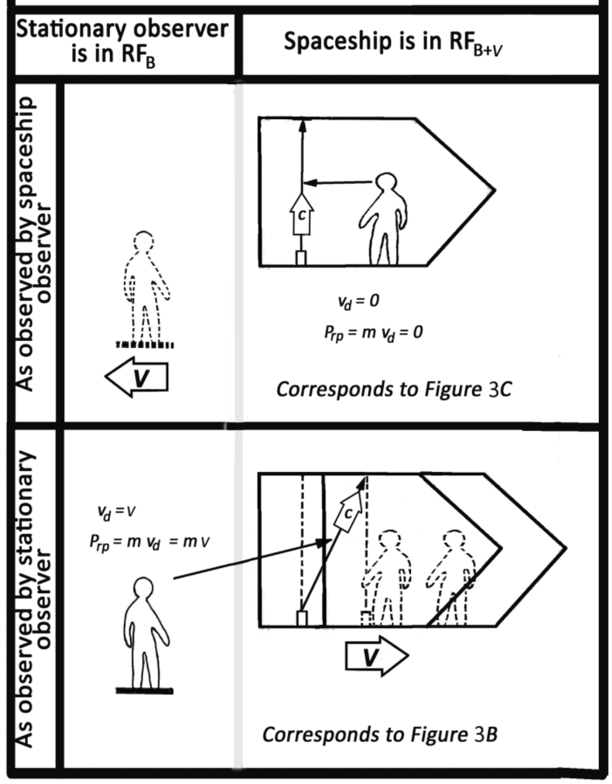
2. Standard Textbook Example of Relativistic Time Dilation

Figure 1 shows a standard textbook example of how the special theory, using the relativity principle, demonstrates time dilation.[8] The thought experiment compares and interprets the observations of a single burst of light as made by observers in two different inertial reference frames. For purposes of illustration, one observer typically is assumed to be stationary relative to another who is moving at a high velocity. In the example shown in Figure 1, the stationary observer is in a base reference frame named RF_B. The other observer is in a spaceship traveling at a high velocity v relative to the base reference frame. Thus, the spaceship's reference frame is designated as RF_{B+v}.

As shown in the top half of Figure 1, the spaceship observer triggers a pulse of light from a laser which is aimed vertically toward the ceiling. Since he is collocated with the laser, the difference in velocity v_d between him and the laser is zero. In his reference frame, the light burst's momentum prior to emission is zero (P_{rp} = m v_d = m 0 = 0). Thus, he observes the light burst travel vertically to light a spot directly above it on the ceiling.

The stationary observer's observation of the same experiment is shown in the bottom half of Figure 1. The difference in velocity v_d between him and the laser is equal to v. In the stationary observer's reference frame, the light burst has a horizontal momentum prior to emission of:

FIGURE 1
Standard Textbook Example of Time Dilation



$$P_{rp} = \text{m } v_d = \text{m } v.$$

Thus, he sees the light travel a greater distance on a diagonal trajectory due to its horizontal momentum in his reference frame.

Light always will be observed to travel at its constant speed c. It travels a longer distance between the same two events (emission and impact) in the stationary observer's reference frame than it does in that of the spaceship observer. Thus, time must pass more slowly in $RF_{B+\Delta v}$ than it does in RF_B. The same observations can be used to show that mass increases[9] and space shrinks[10] when relative inertial velocity is increased.

3. The Hint of a Problem

There is a subtle hint that there may be a problem with the observations. For example, there is only one laser and one burst of light being observed by both observers. How can the same burst of light travel vertically and diagonally at the same time? The relativity principle says that it can (P_{rp} = m v_d). And the laws of mechanics appear to say that it can (P_{lom} = m v)[11]. The two definitions of momentum appear to be the same; v_d and v appear to be simply two ways of denoting velocity. However, the two definitions of momentum are the same only if v_d and v always are the same under all circumstances. That will happen only if v_d and v both experience the same change in value Δv when the spaceship's inertial velocity changes by Δv.

Recall that the relativity principle was developed by Galileo based on experiments involving the motion of physical objects. Such motion is governed by the laws of mechanics. Thus, it is intuitively obvious and generally accepted that the two definitions of momentum are the same. But intuition is not the same as proof. Are v_d and v always the same under all circumstances or are they or not?

4. Comparing v with v_d Before and After Changing the Source's Velocity by Δv

As long as empirical data are limited to observations made in and from inertial reference frames and are interpreted as having equal merit, the difference between the two definitions of momentum is not apparent. The difference can be recognized only by using a *physical* reference frame, such as a spaceship, to step outside the box of inertial motion long enough to *move* the experiment and observer from one *inertial* reference frame to another. This requires *changing* the experiment's velocity v by Δv such that Δv is equal to the *difference* in velocity v_d between those same two reference frames.

The difference in velocity v_d is simply the *observed* constant *difference* between the constant velocities of the two reference frames. Since an observer in an inertial reference frame has no means by which he can determine his own state of motion, other than that it is constant,[12] there is no way to tell if one reference frame is moving and the other is stationary or if it is the reverse.[13] According to the relativity principle, the *difference* in velocity v_d works the same way in both directions.[14] The observer in each reference frame will have the same, identical perception of the other reference frame's motion relative to himself.

The *change* in velocity Δv begins in one inertial reference frame and ends in the other. We know which is the "before" reference frame and which is the "after." It also takes place in a non-inertial reference frame, which captures information not provided by observations made in and from inertial reference frames. For example, we are made aware of the fact that P_{lom} = m v also means that ΔP_{lom} = m Δv. We also know that when the spaceship changes its velocity, neither reference frame changes its state of motion. The only things which can be affected when the spaceship moves to the "after" reference frame are those objects which experienced the acceleration which caused Δv. Thus, the effect of $\Delta P_{lom} = m\,\Delta v$ on the physical trajectory of the experimental object must occur in the "after" reference frame, not in the "before," regardless of where the observers may perceive it to happen.

The new value of the spaceship's velocity v in the new reference frame will change by Δv relative to what it was in the old reference frame. But the value of v_d will change by Δv only for an observer who does not move with the spaceship. For the spaceship observer, who moves with the experiment, v_d always will be equal to zero regardless of the value of Δv. Note that the spaceship's change in velocity was caused by its acceleration as it moved from the old reference frame to the new one. It is inarguable that the spaceship's velocity v is different by Δv in the new reference frame than it was in the old one. But the value the spaceship observer assigns to v_d remains at zero. Clearly, from his vantage point, the two definitions of momentum are no longer the same. If v_d and v were the same in the old reference frame, they no longer are the same in the new one.

The new information provided by this approach allows one to compare how the special theory treats a *change* in an experiment's inertial velocity Δv with how it treats an equal *difference* in velocity v_d between the same two reference frames. Surprisingly, according to the theory's own rules, their treatment is not the same. How can that be?

The new information provided by this approach also allows one to compare how the special theory treats a physical object's change in momentum with how it treats a light burst's change in momentum. Surprisingly, according to the theory's own rules, it treats them differently. How can that be?

The analysis provided below studiously applies the special theory's own postulates and premises, including the relativity principle and the laws of mechanics, to answer those questions.

5. New Information from a New Experimental Design

To accomplish its mission, the experimental design includes the following changes in methodology from what is customarily done when addressing inertial motion:

a. Two different kinds of experiment are conducted concurrently in the same physical reference frame (a spaceship). One of the experiments uses a physical object and the other uses a burst of light.
b. The two kinds of experiment are done concurrently both before and after the spaceship changes its velocity by Δv to move them from one inertial reference frame to another.

This experimental design allows one to make two significant comparisons which apparently have not been made before:

a. One can compare how the special theory treats the effect of a *change* in an experiment's velocity Δv with how it treats the effect of an equal *difference* in velocity v_d between the same two reference frames.
b. One can compare how the special theory treats the effects of Δv and v_d on a physical object with how it treats

their effects on a burst of light using experiments which are both conducted and observed under identical conditions of motion.

As shown below, these comparisons produce a totally new perspective on the relationship between the relativity principle and the laws of mechanics.

6. Experiment Involving the Motion of a Physical Object

As shown in Figure 2, the experiment using a physical object fires a tiny steel ball vertically from a small cannon on the spaceship's floor to strike a target located directly above it on the ceiling. As shown in Figure 2A, the experiment is set up and aligned in the base reference frame, which is named reference frame B, or $RF_{B.}$ The cannon's carefully measured powder charge fires the ball vertically at velocity v_c. The interval of time required for the ball to travel the distance to the target d_h is: $\Delta t_B = d_h/v_c$.

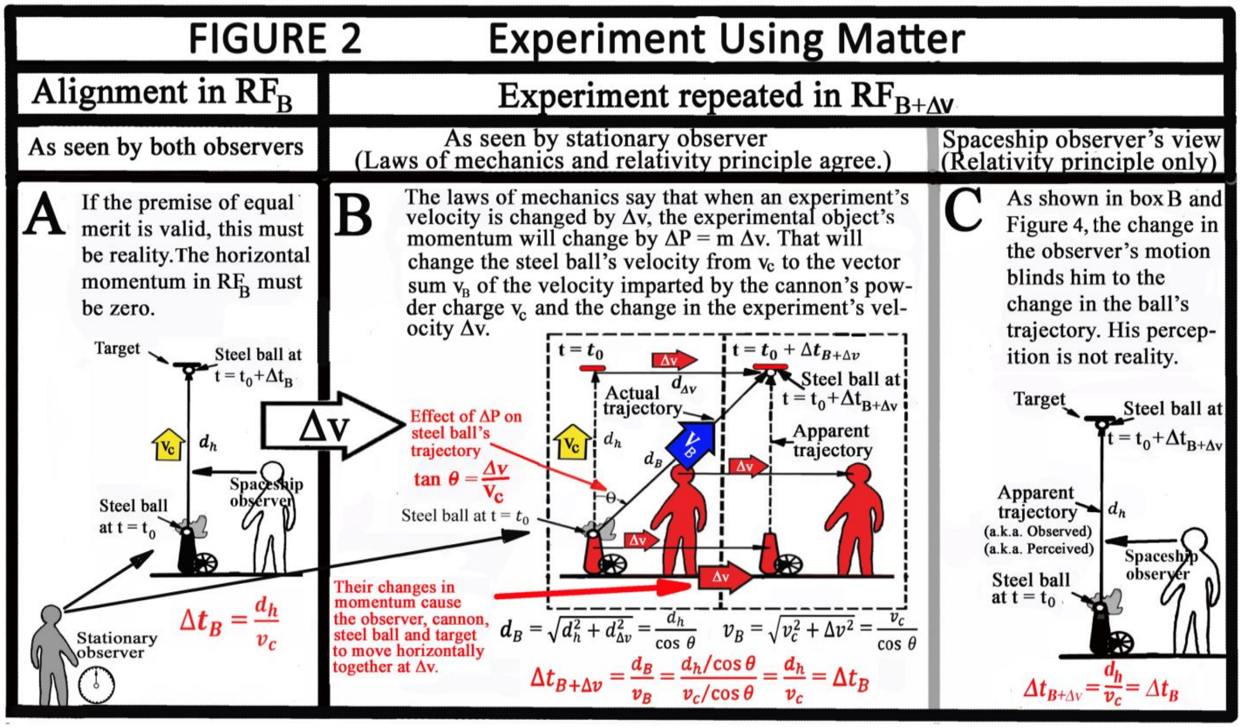
The spaceship's velocity subsequently is changed horizontally by Δv to move the experiment to the other reference frame. The inertial velocity of this reference frame is identical to that of RF_B except for the change in the spaceship's horizontal velocity Δv. Thus, the new reference frame is designated as reference frame B+Δv or $RF_{B+\Delta v}$.

Figure 2B shows the experimental result in $RF_{B+\Delta v}$ *as viewed by a stationary observer* who remained in RF_B. According to the laws of mechanics, the steel ball's horizontal momentum P_{lom} will change from what it was in RF_B by $\Delta P_{lom} = m\,\Delta v$. The ball's post-launch velocity vector v_B will become the *vector sum* of the vertical velocity v_c imparted by the cannon's powder charge and the change in horizontal velocity Δv due to the change in both its own and the cannon's horizontal momentum ($\Delta v = \Delta P_{lom}/m$). Note that from the *stationary* observer's vantage point, the *change* in the spaceship's inertial velocity Δv changes *both* v and v_d *by the same amount*. The experiment moves but the stationary observer does not. Thus, according to him, the resulting velocity vector v_B is consistent both with the laws of mechanics ($\Delta P_{lom} = m\,\Delta v$) and the relativity principle (P_{rp}= $m\,v_d$).[15] What the stationary observer *observes* (relativity principle) is the same as what the laws of mechanics say will happen. The interval of time $\Delta t_{B+\Delta v}$ required for the ball to travel the length of its new trajectory d_B in $RF_{B+\Delta v}$ will be:

$$\Delta t_{B+\Delta v} = d_B/v_B = \frac{d_h/\cos\theta}{v_c/\cos\theta} = d_h/v_c = \Delta t_B$$

According to the stationary observer, the elapsed time between launch and impact for the steel ball experiment is the same in both reference frames. The ratio of distance d_B to velocity v_B in $RF_{B+\Delta v}$ (Figure 2B) is the same as the ratio of distance d_h to velocity v_c in RF_B (Figure 2A). The ball's increase in velocity matches the increase in the length of its trajectory. This also is what his clock will measure. The clock's inertial motion as well as that of the stationary observer remained the same throughout both experiments. Thus, according to the relativity principle, the laws of mechanics, the stationary clock and the stationary observer, the rate at which time passes inside the spaceship in $RF_{B+\Delta v}$ (Figure 2B) is the same as it was in RF_B (Figure 2A).

Figure 2C shows the result of the same steel ball experiment in $RF_{B+\Delta v}$, but does so from the vantage point of the *spaceship* observer. It is important to note that both observers are watching the same experiment which is being



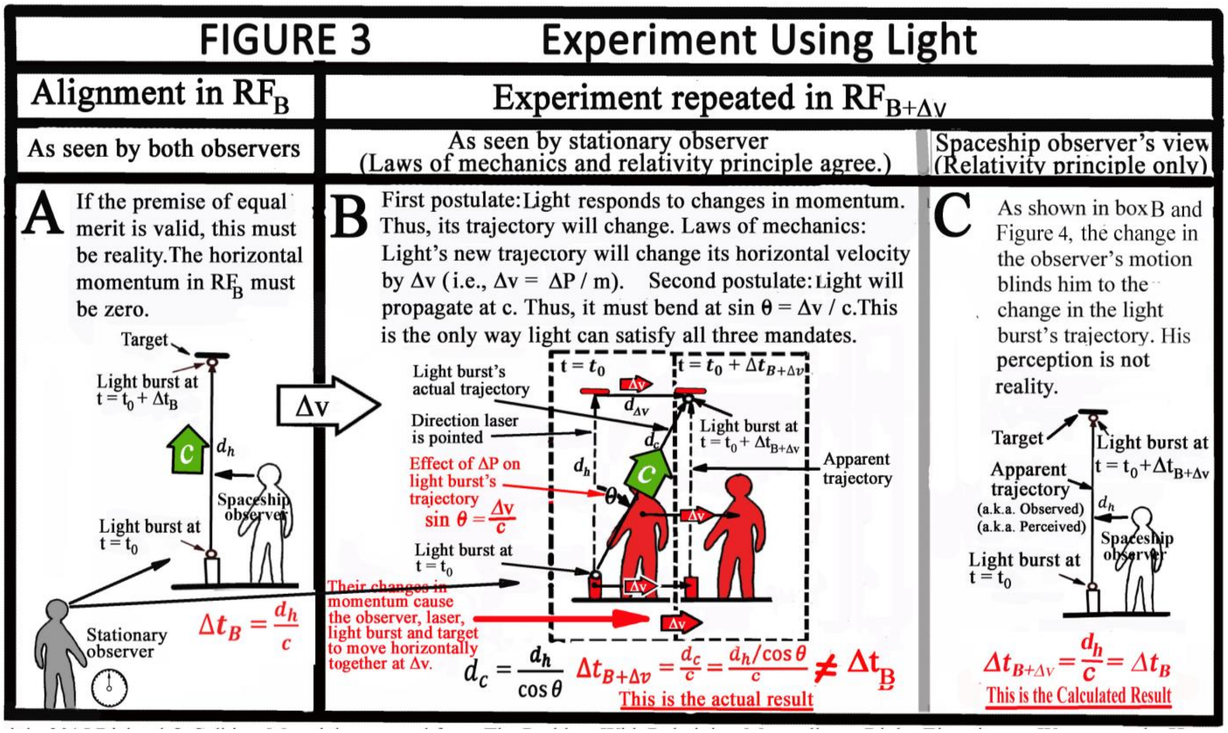
conducted in the same reference frame (i.e., inside the spaceship, which is in $RF_{B+\Delta v}$). However, according to the relativity principle, the *spaceship observer* must observe the same experimental result in $RF_{B+\Delta v}$ as he did in RF_B. (He moved with the experiment. For him, v_d remains at zero.) And this is indeed what happens. Unlike the stationary observer, he *sees* a vertical trajectory between the cannon and the target. When he calculates the time interval $\Delta t_{B+\Delta v}$ by dividing his observed distance d_h by the known vertical velocity imparted by the cannon's powder charge v_c, he gets: $\Delta t_{B+\Delta v}$ = d_h/v_c. That is the same result he got when he and the experiment were in RF_B.

Thus, according to the laws of mechanics, to the relativity principle and to *both* observers, *time must pass at the same rate inside the spaceship when it is in $RF_{B+\Delta v}$ as it did when it was in RF_B.* Contrary to what the special theory would have us believe, there is no indication of time dilation in the physical object experiment. However, the two observers do disagree on the ball's trajectory and speed when the experiment is done in $RF_{B+\Delta v}$. (Figure 2C versus Figure 2B) It is inarguable that the relativity principle produces a different observed result for the spaceship observer when the spaceship is in $RF_{B+\Delta v}$ (Figure 2C) than that required by the laws of mechanics (Figure 2B).

7. Experiment Involving the Propagation of Light

Figure 3 addresses the experiment using the burst of light. As shown in Figure 3A, when the spaceship is in RF_B, a laser mounted on the spaceship's floor is oriented to emit a burst of light vertically to strike a target directly above it on the ceiling. The interval of time for the light to travel the distance d_h from laser to target in RF_B is: $\Delta t_{B+\Delta v}$ = d_h/c.

The spaceship subsequently changes its velocity horizontally by Δv to move the experiment to $RF_{B+\Delta v}$. According to the first principle of relativity, light must respond to a change in the



laser's momentum in the same manner as the steel ball responds to a change in the cannon's momentum. Thus, when the spaceship is in $RF_{B+\Delta v}$, the light burst's trajectory must change from its previous vertical direction (in Figure 3A) to incorporate the momentum-caused change in its post-emission horizontal velocity Δv. However, the second postulate places a constraint on the burst of light which does not apply to the steel ball. Recall that in Figure 2B, the steel ball's velocity vector changed from vertical at v_c to diagonal at the vector sum of v_c and Δv. But the second postulate requires the light burst to travel on its new momentum-adjusted trajectory at its same, uniform speed c.

As shown in Figure 3B, *from the stationary observer's viewpoint*, the *horizontal component* of the light's new trajectory v_h, in $RF_{B+\Delta v}$, will go from v_h = *0* (Figure 3A) to $v_h = \Delta v$ (Figure 3B). Just as with the steel ball, the light burst's change in horizontal velocity Δv matches the change in the laser's horizontal velocity due to the change in their momentum. That will cause the length of the light's trajectory to change, in response to the change in its momentum, but the light burst's speed of propagation will remain at c. As a result, the time interval $\Delta t_{B+\Delta v}$ for the light to complete its trip from laser to target when the spaceship is in $RF_{B+\Delta v}$, as measured by the stationary observer's clock, will change to:

$$\Delta t_{B+\Delta v} = d_c/c = \frac{d_h/\cos\theta}{c}$$

According to the stationary observer and his clock, time passes at the same rate in the spaceship when it is in $RF_{B+\Delta v}$ as it did when it was in RF_B. The difference in the experiment's time interval is caused by the fact that the trajectory's length changed, but the light burst's speed did not.

Note that the stationary observer's observation is backed by both the relativity principle and the laws of mechanics (Figure 3B). The spaceship observer's observation is backed by the relativity principle but conflicts with the laws of mechanics (Figure 3C versus 3B). Clearly, it does not have equal merit. As will be further explained in Section 8, according to the laws of mechanics (Figure 3B), the spaceship observer is moving horizontally at the same speed as the laser, target and light burst. Thus, he cannot see the effects of Δv. Instead, as shown in Figure 3C, he sees the light's trajectory as being vertical. In the textbook examples, the spaceship observer determines the experiment's elapsed time by dividing the illusionary distance he sees the light travel d_h by the constant speed of light c. By doing so, he compounds his observation error by calculating an incorrect elapsed time interval.

$$\Delta t_{B+\Delta v} = \frac{d_h}{c} = \Delta t_B$$

It is this error in his observed trajectory which gives rise to the special theory's predicted time dilation.

In the textbook examples, it is taken on faith that if the spaceship observer had a reliable clock, it would measure the same interval of time as the one he calculates. However, even if that were so, the spaceship observer still would conclude that time passes in the spaceship in $RF_{B+\Delta v}$ at the same rate as when it was in RF_B. (He sees the same, identical result in both reference frames.) Thus, even if his observation were correct, he and the stationary observer still would be in agreement that time passes at the same rate inside the spaceship in both inertial reference frames. All they would disagree on is the trajectories on which the steel ball and the light burst travel and on the time interval required for the light to complete its trip

Neither the "before" and "after" steel ball experiments (Figure 2) nor the "before " and "after" light burst experiments (Figure 3) show any indication of time dilation after the spaceship has moved to $RF_{B+\Delta v}$. But they do show that from the stationary observer's vantage point, the steel ball responds differently to the change in the spaceship's inertial velocity Δv (Figure 2B versus 2A) than does the light burst (Figure 3B versus 3A). Note that the steel ball and light experiments which demonstrate these results are conducted and observed under conditions of absolute consistency. The experiments are conducted concurrently while in identical states of motion. Their results are observed by the same observer and measured by the same clock, both of which remain in the same state of motion throughout the entire exercise. Thus, it is inarguable that the physical object responds differently to a change in the spaceship's inertial velocity Δv than does a burst of light. This outcome isn't a matter of opinion or of interpretation. It is a simple matter of mathematics. A test object which has a constant speed cannot respond to a change in its momentum in the same manner as an object which does not.

It is worth repeating that this information cannot be obtained from observations made exclusively in inertial reference frames. It also is worth noting that these findings are sufficient to show that the special theory of relativity is invalid.

Lacking the information provided by the new experimental design, we have been lulled into believing that the relativity principle is consistent with the laws of mechanics and that it conforms to reality. Both of these assumptions are incorrect. All that the relativity principle describes is what will be *observed* by both observers after the experiment and the spaceship observer have been moved from one reference frame to the other. What actually happens after an experiment's inertial velocity is *changed* is determined by the laws of mechanics (ΔP_{lom} = m Δv), not by the relativity principle. Sometimes the two agree, sometimes they do not. When they disagree, it is the relativity principle which must give way to the laws of mechanics. Perception (a.k.a. an observation) is not the same as reality. (Note that the relativity principle is based on observations of experiments which are subject to the laws of mechanics. If the laws of mechanics were to give way to the relativity principle when they disagree, what, then, would the relativity principle be based on?)

8. Perception is Not Reality

The problem with the relativity principle is that:

a. It is based entirely on observations made in inertial reference frames. Thus, it is based on insufficient information to support a valid interpretation of what is observed.
b. It interprets those observation based on at least two false assumptions:
    - First, it assumes that perception is reality.
    - Second, it assumes that observations made in different inertial reference frames use a consistent definition of motion. As will be shown below, they do not.

As already demonstrated above, the difference between the relativity principle and the laws of mechanics cannot be recognized unless one considers what happens in the non-inertial reference frames which bridge inertial reference frames together. Lacking that information we have assumed, incorrectly, that the relativity principle (Figures 2C and 3C) is consistent with the laws of mechanics (Figures 2B and 3B). It is not.

We now will address the above-stated false assumptions which led us into the labyrinth of relativity and which have trapped us there for more than a century.

It is an unavoidable consequence of the human condition that everything we believe is hostage to implicit assumptions. Implicit assumptions are hidden in our subconscious. They are things we believe so implicitly that we don't even have to think about them. We aren't even consciously aware of them. But they have a profound effect on how we think. For example, we are consciously aware that perception is not reality but unquestioningly accept empirical *observations* as showing what is real. We forget that an empirical observation has no meaning except that which we give it through our interpretation.

Our interpretation is the result of a human decision process. That process is based on what we know, which is just another word for what we believe, which includes the assumptions hidden away in our subconscious. Believing, implicitly, that what we see with our own eyes is real, we have accepted Galileo's *observations* as unquestionable representations of reality. But as shown in Figures 2 and 3, after an experiment has been moved from one inertial reference frame to another, the spaceship observer, who is in the reference frame where the change occurs, cannot detect it. It is the stationary observer whose state of motion remained constant, who observes the change.

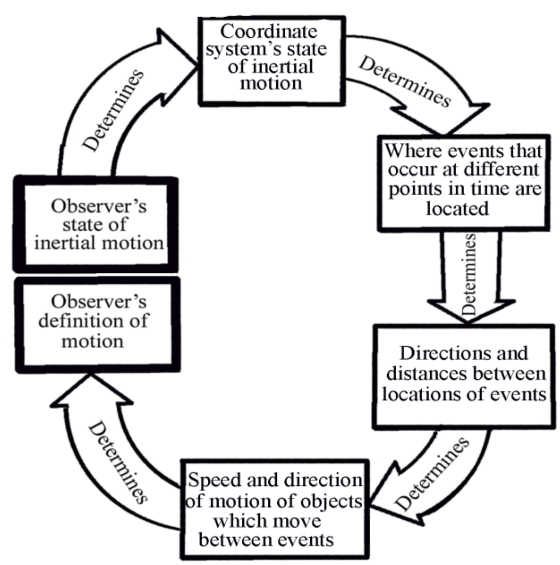
There are two ways by which the spaceship observer's problem can be unveiled. The first, way was touched on briefly in Section 7. As shown in red in Figures 2B and 3B, the change in the spaceship observer's horizontal motion matches the change in the horizontal motion of the source, the target and the experimental object. Although the changes have occurred in $RF_{B+\Delta v}$ (laws of mechanics) the spaceship observer has no means by which he can detect them (relativity principle). After he has arrived in $RF_{B+\Delta v}$, the spaceship observer feels stationary, just as he did when the spaceship was in RF_B. He remains stationary relative to both the source and the target in $RF_{B+\Delta v}$, just as he did when the spaceship was in RF_B. And he has no means by which he can detect the horizontal component of the test object's diagonal trajectory as it transits from source to target. The laws of mechanics mandate that the experiments, when done in $RF_{B+\Delta}$, produce the results shown in Figures 2B and 3B. However, because of the limitations the human condition imposes on his ability perceive and define motion, the spaceship observer sees what is shown in Figures 2C and 3C. His observations do not conform to reality.

The second way to explain that same result is shown in Figure 4. Based on how the human condition has equipped our sensory capability, both an observer's perception of motion and even his definition of motion change when he changes his state of inertial motion. After the experiment has been moved to $RF_{B+\Delta v}$, the spaceship observer no longer agrees with the stationary observer simply because his definition of what constitutes the direction and magnitude of motion has changed. Indeed, every observer in every different inertial reference frame perceives and defines motion differently than the others. Each of them has a definition of motion that is entirely subjective and that is determined by his unique and personal state of motion. That same condition also applies to the human-designed apparatus he uses to observe motion (e.g., high speed video cameras and radar sets).

If there are n observers in n different inertial reference frames who are observing the same experiment, their *observations* all can be wrong in their perception of what happened but only one of them can be right. Whichever one is right, if any, the other n-1 observers will be wrong. This is what Maxwell was telling us with his unique, preferred reference frame for observing the correct speed of light.[16] That preferred reference frame results directly from the laws of physics which govern the propagation of light and which determine its constant speed.[17] According to Maxwell's equations, they are different from the laws of

FIGURE 4

An Observer's Definition of Motion is Entirely Subjective and is Determined by His Own State of Motion



mechanics.[18] The means by which one can identify that unique reference frame is beyond the scope of this paper but can be found in *The Problem with Relativity: Maxwell was Right, Einstein was Wrong and the Human Condition Prevailed.*[19]

9. Conclusions

Bottom line, the relativity principle is based on a clever parlor trick the human condition has been playing on us for more than three centuries. Our acceptance of Galileo's *interpretation* of his observations is based on an unrecognized (implicit) assumption that what he *observed* was the same as what actually happened. That seems reasonable when stated as "seeing is believing" and even more acceptable when stated as "experiments made in all inertial reference frames will produce the same result." But it still is an example of "perception is reality" and still is incorrect.

Contrary to what the relativity principle claims, the experimental result will be different in each different inertial reference frame. For each reference frame to which the experiment is moved, the magnitude of Δv will be different. ΔP_{lom} = m Δv will be different. Thus, the trajectory followed by the experimental object will be different. The stationary observer will observe the differences. It is only the *observation* by the observer who *moves with the experiment* which remains the same. That is because the change in his state of motion Δv changes how he perceives and defines motion by $-\Delta v$.

It is not unreasonable to posit that evolution favors the survival of species whose members have highly developed instincts for detecting and assessing the motion of predators and prey *relative to themselves*. There is little, if any, survival benefit in the ability to detect and assess motion relative to a reference frame which can be identified only with a tightly focused optical laser.[20] That ability becomes useful only to a species which has advanced to the point of wanting to understand how the universe works. We are now at that point. Fortunately, we also now have the tools to detect and measure motion relative to a unique reference frame which is stationary according to the laws of physics which govern the propagation of light.[21] It will be highly useful as a common reference frame for recording and analyzing motion in a consistent manner with a consistent definition of motion. That will allow us to distinguish between those observations which conform to reality and those which do not. Weeding out the invalid observations will allow us to create a theory of motion which more accurately describes the cosmos than do the theories we now have.

As soon as one steps outside the inertial motion box to *move* the experiment from one inertial reference frame to another, it becomes clear that the *change* in the experimental object's motion and momentum are caused by Δv, not by v_d. The laws of mechanics are laws of physics. The relativity principle, which is based on what Galileo *observed,* is merely a principle of observation (a.k.a. perception). Sometimes they agree; sometimes they do not. Accordingly, the special theory of relativity is invalidated by:

a. An incorrect understanding of the relativity principle, leading to
b. Incorrect interpretations of empirical observations and
c. An unrecognized but irreconcilable conflict between the second and first postulates of relativity.

Treating raw empirical observations as if they have equal merit leads to incorrect interpretations of empirical observations. Incorrect interpretations of empirical observations lead not only to false theories, they also lead to perpetual false empirical validation of false theories. The special theory of relativity is a prime example of this outcome

Endnotes

[1] Douglas G. Giancoli, *Physics*, 4th edition (Englewood Cliffs, New Jersey: Prentice Hall, 1995), 744-745. Goldsmith, Dr. Donald, and Robert Libbon, *Einstein: A Relative History* (New York: Simon&Schuster, Inc., 2005), 69. Physics Central, physicscentral.com/explore/plus/Galilean-relativity.cfm.
[2] Ibid.
[3] Knight, Randall D., *Physics for Scientists and Engineers: A Strategic Approach, Volume 3.* (San Francisco, California: Pearson Addison Wesley, 2004), 1156.
[4] Physics Central, physicscentral.com/explore/plus/Galilean-relativity.cfm.
[5] Ibid.
[6] Ibid.
[7] The subscript rp has been added to the term for momentum P to distinguish momentum as defined by the relativity principle from momentum as defined by the laws of mechanics.
[8] Giancoli, *Physics,* 753-757. Cutnell, John D., and Kenneth W. Johnson, *Physics,* 5th edition (New York: John Wiley & Sons, Inc., 2001), 867-871. Young, Hugh D., and Roger A. Freedman, *Sears and Zemansky's University Physics, Volume 3,* 11th edition (San Francisco, California: Pearson Addison Wesley, 2004), 1409-1413.
[9] Goldsmith, *Einstein: A Relative History*, 73. Giancoli, *Physics*, 762.
[10] Goldsmith, *Einstein: A Relative History*, 73. Giancoli, *Physics*, 758-759. Knight, Randall D., *Physics for Scientists and Engineers,* 1171-1174.
[11] The subscript lom is added to the term for momentum *P* to distinguish momentum as defined by the laws of mechanics from momentum as described by the relativity principle.
[12] Goldsmith, *Einstein: A Relative History* 48*,* 67-70.
[13] Gribbin, John and Mary Gribben, *Annus Mirabilis: 1905, Albert Einstein, and the Theory of Relativity* (New York: Chamberlain Bros., Penguin Group, Inc., 2005), 100-101.
[14] Ibid.
[15] There is a subtle difference between v and v_d that must be understood here. When the experiment is moved from RF_B to $RF_{B+\Delta v}$, its velocity v changes by Δv. That change is caused by the acceleration experienced when in non-inertial motion between the two reference frames. The *change* in velocity and the corresponding *change* in momentum exist inside the spaceship when the spaceship is in $RF_{B+\Delta v}$. It exists there whether or not it is observed. In contrast, whether v_d changes or not depends on the observer. An observer who does *not* change his inertial motion will see both v and v_d change by Δv. An observer who remains collocated with the experiment will see no change. That the *change* in the experiment's momentum happens during the (non-inertial) trip from RF_B to $RF_{B+\Delta v}$ is inarguable. The change in momentum after the experiment has arrived in $RF_{B+\Delta v}$ is caused by Δv. It can exist only in the "after Δv" reference frame, not the "before." The reason the collocated observer cannot detect the experiment's change is because both his sensory detection of motion and his coordinate system's recording of motion have changed by -Δv to eliminate it.
[16] Giancoli, *Physics*, 745.
[17] Calkins, Richard O., *The Problem with Relativity, Maxwell was Right, Einstein was Wrong and the Human Condition Prevailed* (Sammamish, Washington: A Different Perception, 2015), Appendix A.
[18] Giancoli, *Physics*, 745.
[19] Calkins, Richard O., *The Problem with Relativity, Maxwell was Right, Einstein was Wrong and the Human Condition Prevailed* (Sammamish, Washington: A Different Perception, 2015).
[20] Calkins, Richard O., *The Problem with Relativity,* 51-70.
[21] Ibid.