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Chapter

Clarifying Special Relativity

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Abstract

Special relativity for light requires substantial correction. The notion that time dilates for observers in motion has been disproven theoretically, experimentally, and mathematically. Absolute time is not altered by the motion of objects or human activity. The original concept used distance and light velocity improperly to compute time. When the displacement of objects in relation to the traveling direction of a photon of light is considered properly, both stationary and moving observers compute time for any particular event that is equal. Light photons travel at intrinsic speed c in the propagation direction but have component velocities less than c. Although light velocity c cannot be altered by motion of its source in the propagation direction, photons from a lateral moving source experience a lateral velocity component and angle travel from the source at speed c in that direction. Due to motion of the earth in its orbit, objects that are seen are images from a former location when the light departed. More or less time is required for light to traverse objects in motion than when stationary. This is not due to dilation of absolute time. Fixed light speed ensures that differing distances require differing times for light to travel.

Keywords: light, time, relative measurements, nature of light

1. Introduction to relativity

Most all measurements in the physical world are subject to relativity. Any object viewed from a distance appears smaller than its size seen at a closer distance. Its actual size however is the same, independent of the distance from which it is viewed. Likewise, time can feel very long when one is bored but very short when one is entertained, when the actual time is the same independent of such feelings. Relativity is this fact that perceptions for a particular object or event can differ for different observers and can depend on one's vantage point.

It is true that different observers watching a given event will describe that event differently. In this way relativity can be of particular value. The different disciples' accounts of Jesus reflect features differently that present a more complete picture for those reading the gospels. In other cases, relativity may be a hindrance that must be adjusted for, such as when determining the actual true value of a scientific measurement. Relativity can cause a measurement to be made incorrectly. Even though the absolute time for an event itself does not respond to physical changes of matter and is independent of whether matter exists or not, a long-held notion called time dilation is widely taught as fact in many Physics texts and must be explained. Time dilation stemmed from thoughts regarding the use of light and physical objects to attempt to measure time. Some examples use a lateral moving "light box" containing a light source that is represented to measure time, and other instances use a linear moving rod or train car that must be traversed by light. In all cases, observers

moving with the device perceive a different distance of travel than that for observers who are stationary who notice the motion of the device. In reality, light must travel farther to reach a receding target or less to reach an approaching target, whether a box, train, or rod that moves during the photon travel time, all while the time required to travel that distance is a single correct value. The true time for any event is not affected by one's position to observe the event. Umpires not in a position to observe well a play in a sports event often make incorrect decisions. Likewise measurement of time using fixed-speed light that interacts with matter depends on the relative motion of that matter. If it is observed easily, the correct time may be determined. If not, and not properly corrected, a meaningless time will result.

All scientific instruments must be calibrated for variables that affect readings, or the readings will be incorrect, and this includes the measurement of time using light. A watch with a lead weight placed on its hands ticks more slowly and reports a wrong time for an event. And this does not change the actual time required for the event to occur! Time cannot be measured correctly with a moving light box, or train or rod UNLESS the direction and magnitude of motion of the box or rod or train in relation to the propagating photon are known, and used to determine actual displacement of the light in the direction at which its velocity is known. Any light clock velocity unequal to zero, or moisture in the air that slows light speed, causes light clocks to report a time that is not the correct time. Real time for an event is not subject to motion of a device attempting to measure it. Real time is determined by the event itself, independent of whether an observer runs away, runs toward, or remains still with respect to the event. Twins are the same age, whether one runs differently than the other or travels in spacecraft.

2. Light is massless and propagates at fixed speed c

A photon of light is electromagnetic energy that can only exist while traveling at a fixed fast speed in a given medium and that propagates in perpetuity if uninterrupted by physical matter. James Clerk Maxwell (1865) successfully derived mathematically the speed with which light must propagate in a given medium from the point in space at which it is produced, where $c = \mathbf{E}/\mathbf{B} = 1/(\varepsilon\upsilon)^{1/2}$. **E** and **B** are the amplitudes of the electrical and magnetic field orthogonal components of light, and ε and υ are the electrical permittivity and magnetic permeability of the particular translucent medium in which light propagates. In vacuum, the speed of light is approximately $c = 2.99792 \times 10^8$ m/s. The Nobel prize-winning American physicist from Poland, Albert Michelson, directly measured the speed of light experimentally in the San Gabriel mountains of California in 1926. The round-trip for light to travel from Mount Wilson near Pasadena to Lookout mountain at Mt. Baldy (Mt. San Antonio) near Alta Loma is a ground distance of 44 miles. Knowing the rotation speed of a rotating slotted set of mirrors and thus the time between successive slots through which light passed, the speed of light was computed to 6 digit accuracy at 2.99792×10^8 m/s, confirming experimentally the correctness of the Maxwell theoretic derivation. We now know that because the earth orbits the sun and light travels in fixed straight paths at a speed that does not add to that of the earth, that the true time to travel this 44 mile round-trip is slightly different because the total travel distance is larger due to the earth's motion during the photon travel time.

3. Time for light to traverse a moving object is relative: one-dimensional case

The distance between two trees along the ground is **D** km (**Figure 1**). Because the speed of light in its propagation direction is c from the spatial coordinate at which



Figure 1.
The ground distance traveled by a photon from one tree to another tree differs from the actual distance the photon travels because the trees move along with the orbiting earth while the speed of light is nevertheless constant.

it departs its source (that is, a stationary point in space) then the time required for a light photon to travel from the pine to the oak here would be $t = \mathbf{D}/c$ if the earth were stationary. However the earth orbits the sun at 30 km/s and, ignoring any contribution from any translational or rotational motion of the solar system, the more accurate distance the photon actually travels between the trees is directed distance **D** plus the distance the earth moves parallel to **D** (in the direction the photon travels) during the photon travel time between the trees, where $t = (\mathbf{D} + 30\ t)/c$ so that $t = \mathbf{D}/(c - \mathbf{v}) = \mathbf{D}/(c - 30)$. Thus the true time for an event involving light interacting with material mass must be computed with proper vector algebra where the actual distance of travel must be known. Moreover, a stationary observer on earth easily computes an incorrect time as $\mathbf{D}/c$ because it is simple to assume the actual distance traveled is only **D** when it is not. The total distance is greater than **D** when the earth moves in the direction the photon travels and less than **D** when the earth moves opposite to the photon. Note that c in this case is the magnitude of the velocity of the photon in its travel direction and thus c and **D** are both vector quantities in this case.

The original notion of time dilation derived from thoughts regarding a forward moving rod traversed by light. It was assumed that an observer on the rod would compute the time for light to traverse the rod forward and then backward again as $2\ \mathbf{L}/c$ where L is the length of the rod. A stationary observer watching the moving rod would notice the distance traveled by the rod while light was traversing it and would compute a different time than $2\ \mathbf{L}/c$. On closer inspection it is clear that the actual time required for light to make such a round trip on a moving rod depends on the velocity of the rod (1, 3) and when computed properly by the moving observer matches the time computed by the stationary observer. If the rod were to move at very fast sub-light speeds, the light would not reach the end of the rod for a long time interval but using a clock instead of the length of the rod by the moving observer would report that prolonged time correctly. It was mistakenly assumed that the shorter time for light to return to the rod, where the relative velocity would be $c + \mathbf{v}$ when the rod approaches the light, would cancel the longer time the light requires to reach the end of the receding rod on the forward trip. This is not the case, where the total travel round-trip time is given by $t = \mathbf{D}/(c - \mathbf{v}) + \mathbf{D}/(c + \mathbf{v}) = 2\mathbf{D}/(c - \mathbf{v}^2/c)$. Notice that if $\mathbf{v} = c$, t would be infinite since the light would not catch the rod end. When **v** is zero then $t = 2\mathbf{D}/c$, the time for a round-trip travel for light on a stationary rod. The faster the **v** of the rod, the longer is the time required to round-trip the rod. There is no dilation of absolute time, simply a longer time is required for a longer trip to be completed.

This system involves both classical and special relativity to understand. Classically distances traveled by any object moving at a particular speed toward a target that is also moving always depend on the relative motion of the target. The actual distance traveled may be greater or less than the original distance to the target at the time the light departs its source. The actual distance traveled by a photon to the target is relative to the distance moved by the target. One may perceive the photon only traveled the distance of separation between the source and target, when in actuality the photon travels a different path since the target moved during the time of travel for the light, while light speed is fixed.

Also in the light trees example here, since light speed is fixed at c with respect to a stationary coordinate in space, this special behavior of light requires one only use this speed or its proper component in relation to the travel directions of the light and the moving target. The speed of light is fixed in a given medium, unlike physical objects which pick up additional speed and energy $1/2\ mv^2$ from moving sources. Both sound waves and light waves also travel at a fixed speed even from moving sources. The frequency and wavelength of the sound or light are changed, but not the speed which is the product of frequency f times wavelength λ and for light we write $c = f\lambda$. Although the frequency of light and its intrinsic energy $E = hf$ where h is Planck's constant are increased by a source moving in its propagation direction, it is not possible to increase its speed which is fixed at c. A rifle bullet travels between the two trees on the moving earth at a combined speed of muzzle velocity plus earth orbit velocity, so the time to reach the target tree is simply **D** divided by the muzzle velocity because the extra distance moved by the trees during the bullet travel time is matched and overcome by the extra velocity the bullet has from the moving earth. This is not the case for light which must travel at fixed speed c independent of motion of its source or the target toward which it speeds. This is the key aspect of special relativity. Light, but not true for physical objects, emanating from moving sources requires different times to travel to a target in motion than when stationary.

Another special property of light is that it is massless and its propagation speed c is not exceeded by any object having mass. However before proceeding to the two dimensional light box case, it must be emphasized that light velocity is simple to exceed, because light is only velocity c specifically in its travel direction [1]. Velocity components for a light ray are less than c and may be easily exceeded by physical objects. Merely point a laser light North and you walk East and you will reach an Eastern target that the light does not, because you exceeded the Eastward component velocity of the light ray.

From the above relativity considerations, to compute time for an event that involves using light interacting with physical objects, it is necessary to match distance and velocity vectors, or the computed time will simply be incorrect. The original concept of time dilation unfortunately did not consider vector algebra when computing time for theoretic light timing devices in either the linear or lateral motion cases and these have now been corrected. The concept of dilation of time, presumed to occur when light is used as a time piece, has been disproven, theoretically, mathematically, and experimentally (1–3).

3.1 Two-dimensional case: a light box

A light photon in a *stationary* light box travels the height of the box **d** in time **d/c** (**Figure 2**).

However, in a *lateral moving* light box, a photon must have a horizontal component velocity equal to that of the box **v** in order to hit the moving box top spot. A stationary observer sees the true path **r** of the photon (**Figure 3**) and calculates the correct time **r**/c.

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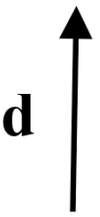


Figure 2.
The arrow represents the path a photon could take from its source to the top of a box with height ***d*** *that is imagined to be stationary.*



Figure 3.
The arrow represents the path of a photon emitted from its source to the top of the box of height ***d*** *when the box is imagined to be moving rapidly laterally. The path distance to reach the to of the box is now length* ***r****.*

The vector **r** does not represent a beam of light, but rather the path traced by a single photon. This is because the photon that arrives at the top of the box left the source when it was at its leftward position earlier as shown. The source at the time of arrival is vertically directly under the arriving photon in the box, and photons leaving the source at that time begin their angled path from this new source location and will arrive at the target after it shifts to another location. So photons all angle travel with this bearing and arrive at the target later at another shifted position. Several photons produced in succession cause the illusion that all traveled vertically to the target, when actually all angle travel distance **r** to arrive. An observer inside the box who only notices the vertical component of the photons could falsely compute time as if it were **d**/c. But light photons in the moving box did not follow the path along vector **d**. Each actually follows a vector parallel to **r** to reach the moving spot on the box top. **d**/c is false because it is a vector mismatch. Correct displacements for light must be determined not by appearance, but by truth, before time can be calculated correctly. Just like a virtual image is not a real image, the appearance that light followed **d** for the moving box is a mirage, not the real displacement path **r**. Notice that a stationary observer far to the right might also assume the photons only moved upward distance **d** and could compute time incorrectly, so the incorrect computation has nothing to do with motion (or not) of an observer.

It is improper to claim that time "slows down" for some event simply because an observer moves during that event. Light cannot sense that an observer is in motion, to adjust its time required to travel a particular distance. Stated simply, a longer distance requires a longer travel time for light at a fixed velocity than a shorter distance, regardless of the state of motion of any observer.

To avoid a vector algebra blunder, it is always mathematically necessary to couple the correct light velocity component with the vector component actually traveled with that velocity. In this way, time calculated for any particular event is the same for any observer, regardless of their state of motion. Note that in time **d**/c, the photon above travels distance **d** (since velocity c times time t equals distance: **d** = c(**d**/c) = **d**). This means that the photon traveling along vector **r** travels a distance **d** in time **d**/c but of course has not yet reached the box top at **r**.

Experiments conducted at Palomar Community College with a laser light [1–3] demonstrate that light photons that propagate at speed c pick up lateral velocity when produced by a lateral moving source and thus have a component velocity

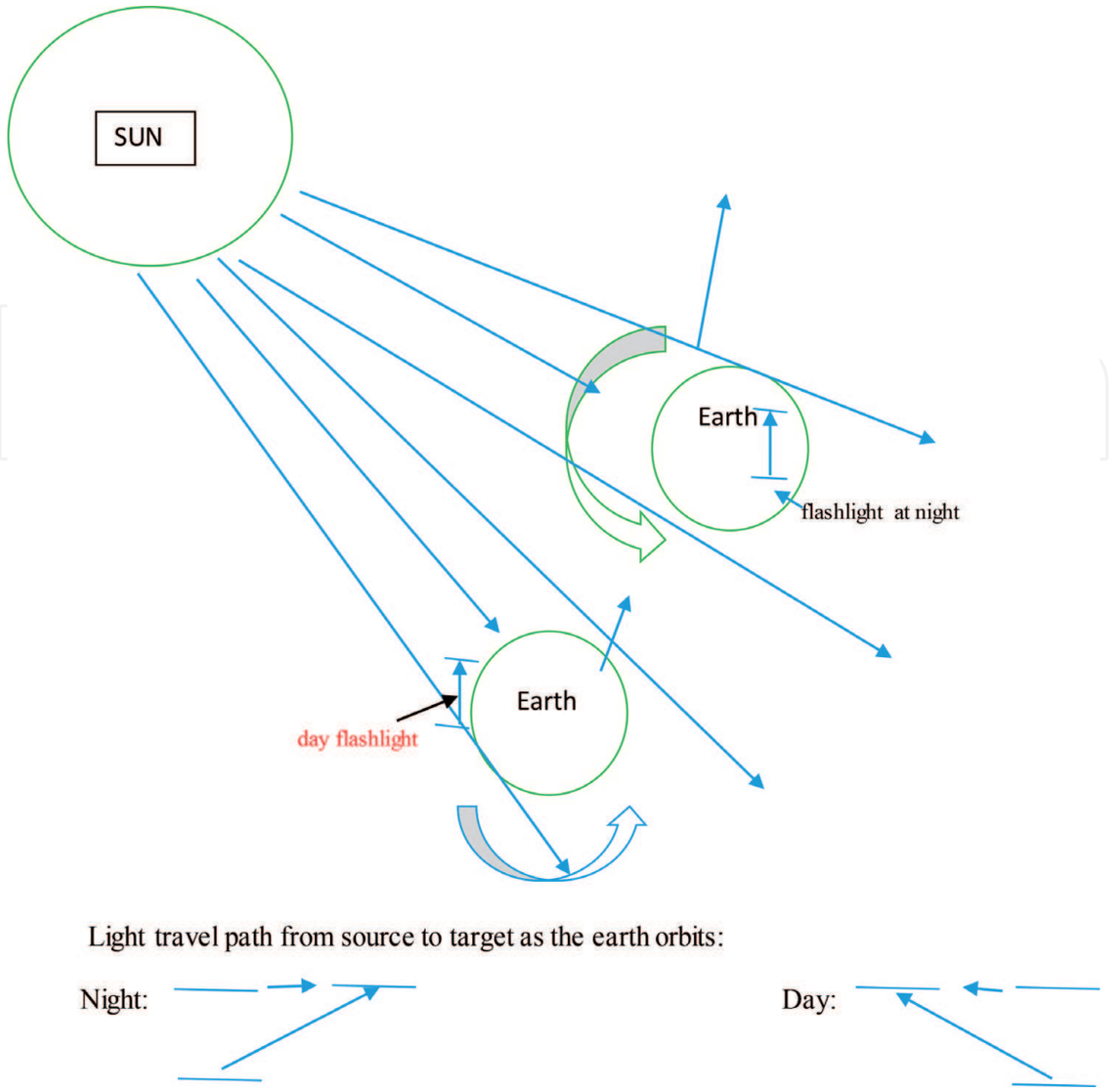


Figure 4.
Diagram depicting the experiment conducted with a laser light continuously illuminating a target 30 m distant while on the rotating and orbiting earth. Light photons travel north to the target, while earth and target orbit 65,000 mph laterally around the Sun. This experiment proves that light photons angle-travel in a straight line and catch the target on earth which shifts laterally 1.3 mm during the time it takes for the photon to arrive. The photons do not simply travel 30 m north and miss the center of the target. Because the earth spins like a twirling figure skater also circling a rink, the 3 mm shift is east of its original position when the photon left the source at midnight but 3 mm west of its original position when a photon leaves at noon. The light continuously on for 24 h periods nevertheless always lands on the center of the target. The photon travel path is thus always larger than the 30 m distance along the ground to the target, because the earth never stops orbiting. Thus photons take longer to reach the target because the earth target is always shifting away from the light. This extension of travel time is not a "dilation" of absolute time due to the motion, but is simply due to the longer distance traveled compared to the time to travel 30 m if the earth were not moving. Anyone who computes time as 30/c rather than (30 + d)/c is sincere, but wrong. Time does not slow down or dilate when objects move. Motion has nothing to do with the fact that absolute time marches on. The special theory of relativity is here modified to indicate that time dilation does not exist, while light remains special in propagating at fixed forward speed independent of motion of the source.

equal to that of the source (**Figure 4**). While a photon travels at speed c 30 m to a target, an observer on earth, orbiting with the source and target, would be incorrect to computer time as 30/c because the photon actually travels farther than the ground distance to the target. Since the earth orbits at 30 km/s, the target and source move laterally 3 mm West at noon (or 3 mm East at midnight) during the time required for a photon to propagate 30 m North. Thus the true travel time to arrive at the new target position is slightly longer than if the earth were stationary. A stationary observer in outer space could see such an angled travel path, while a moving observer on earth would not and the photon travel distance would then

need to be calculated. This distance must be used by either stationary or moving observers in order to compute a correct time interval when using light to measure time. Light boxes are inferior timepieces because physical objects on the orbiting rotating earth are always in motion.

Light speed in fog is slower than in dry air. So the number of light box ticks (photon round-trips) in fog is always less than for dry air, for any specific event being timed by a 'light clock". Twins 1 year from now will not be different in age simply because one lives in fog and measures time with a foggy light box. This foggy clock reports a different time for an event compared to what a dry clock reports, not because the actual time is different, but because the clock is affected. Light "clocks" must be calibrated for humidity, or else the reported time is incorrect.

As for any scientific instrument, all variables affecting its operation must be calibrated. Light boxes are affected by lateral velocity from the point at which the light leaves its source. The equation for this dependence is correctly derived in Physics textbooks as: $t = \mathbf{d}/(c^2 - \mathbf{v}^2)^{1/2}$, where $\mathbf{v}$ is the lateral velocity of the box with respect to a stationary point. At $\mathbf{v} = 0$, the box is stationary, and the time reported by the clock is $\mathbf{d}/c$ for the event where light travels $\mathbf{d}$. But the clock in motion reports a smaller number of ticks (or round-trips for a light photon inside the box) for that same given event being timed. The observer inside the box who uses $t = \mathbf{d}/c$ for the moving box has wrongly placed 0 for $\mathbf{v}$ into the formula. The formula must be followed to obtain a correct time, and $\mathbf{v}$ is not 0 for the moving box. $\mathbf{d}/c$ is a nonsensical computation for a moving box because more time is required for a tick at the longer distance required by light to travel. Time doesn't slow, it is simply that it takes longer for light to arrive.

Only when velocity of the box (and humidity of the air inside) is calibrated can a correct time interval be reported. Humidity is needed to know the value of c, and $\mathbf{v}$ is needed to know the displacement distance that photons travel before the clock registers a tick.

The typical Physics textbook conclusion, that since a moving light box ticks more slowly then absolute time itself "slows" [4] does not appreciate that the clock operation is altered by its own motion, similar to being slowed when operating in fog. The explanations of the Hafele-Keating experiment with atomic clocks in airplanes, environmental muon lifespans, the perihelion progression of the planet Mercury, or the actual meaning of the Michelson-Morley split light beam interferometer data have all been presented earlier without need to invent the notion of time dilation [2].

An additional proper way to calculate t for the moving observer inside a light box, moving lateral with velocity $\mathbf{v}_x$, is to match the vertical net displacement $\mathbf{d}$ with the velocity component for the photon in that vertical direction, which is $\mathbf{v}_y = c\sin\theta$ (where θ is the angle made by the vector $\mathbf{r}$ from the horizontal). Here $\sin\theta$ is $\mathbf{d}/\mathbf{r}$. Time then becomes $t = \mathbf{d}/c\sin\theta = \mathbf{d}/(c\mathbf{d}/\mathbf{r}) = r/c$, the same time as properly computed by the stationary observer. Although there are several other possible incorrect ways to compute time for this event, these are not further discussed here.

Note that if the light box moves in the direction of the long axis of the box, the box top recedes from the propagating photon, and the equation for time is $t = \mathbf{d}/(c - \mathbf{v})$ (from Einstein, 1905) [5]. This is because the relative, net velocity of the photon toward the top of the box, $c - \mathbf{v}$, depends directly on the receding velocity $\mathbf{v}$ of the box. The equation becomes very complicated if the box velocity is neither perpendicular nor parallel to the orientation of the box. If the box were to remain aligned with the Y axis, then the time for a photon to traverse the moving box with horizontal velocity $\mathbf{v}_x$ and $\mathbf{v}_y$ is $t = [2\mathbf{v}_y \pm (4\mathbf{v}_y^2 + 4\mathbf{d}^2 + c^2 = \mathbf{v}_x^2 = \mathbf{v}_y^2))^{1/2}]/c$. If the box velocity involves three dimensions, the equation becomes even more complex, which proves that a light box is an improper device for measuring the time for an event. (A light box is however a good motion detector since light arrives at a position other than a target spot when only slight motion of the source with respect to the detector occurs).

4. Simultaneity is not relative

A similar problem affects textbook examples attempting to prove that *simultaneity* is somehow dependent on motion of an observer [6]. Either two events occurred at the same time t, or they occurred at two different times. For example, two light waves or sound waves of fixed speed, produced at the same instant, arrive at an observer at different times if the observer is in motion and shifts from the midpoint. This is due to different distances for each wave to reach him. This does not mean that the waves were themselves produced at different times, but that they traveled different distances to reach him. The stationary observer directly at the midpoint between the two sources would of course conclude correctly that the waves were produced simultaneously. A moving observer must adjust the distance to the source origins by the amount he shifted from the midpoint during the wave travel time, to know whether they were simultaneously produced.

5. Special relativity

Relativity for light is indeed special because light is special. Unlike for objects with mass, light speed from its origin in space in the propagation direction is fixed in a given medium. Firing a bullet inside a lateral moving box similar to the light box example does not change the time required for the bullet to reach the top of the box. This is because for physical objects that have no fixed speed, the intrinsic muzzle speed provided by the source adds to the additional velocity provided by the moving box so that the total speed is greater. Thus the time to arrive at the top of the box, traveling the additional distance due to motion of the box, is the same as that required to reach the top of the box when stationary, **d/v** where **v** is the intrinsic velocity in the vertical direction for the bullet. Whether the box is moving or not, **v** in the vertical direction remains the same. The horizontal component is in addition to its intrinsic component in the vertical direction, so the bullet has more kinetic energy due to the added lateral velocity. Light however must travel at fixed intrinsic speed c = **E/B** which is always a constant in a given medium in the direction it propagates, regardless of motion of its source. Indeed, sunlight from the edge of the spinning sun that recedes from view is redshifted compared to light from the edge spinning toward the earth which is blue shifted, while the various colors of light all travel at the same intrinsic speed c. A forward moving light source produces light with greater energy but it is not kinetic energy and is rather intrinsic electromagnetic energy. Light reflected or scattered from physical objects, such as the well-known Compton scattering, loses some energy and departs with a lower energy and lower frequency but travels with a longer wavelength, again at required speed c. These properties of light mean that a light box would be a useful device for measuring relative motions of objects, such as during earthquakes or the ground motion associated with tidal drift, but would not be useful to measure time because light speed does not add to source speed.

6. General relativity

General relativity usually centers on the notion that force fields can be indistinguishable in some experiments and attempts to explain the nature of gravity. But it is mistaken to extrapolate that force fields, whether due to gravity or due to contact forces, are identical and indistinguishable. For example, gravity requires no physical contact with the object being accelerated, as Newton wrote gravity generates forces

from great distances. Contact forces that replicate that magnitude of acceleration do require physical contact. If a box were accelerated laterally by either gravity or a physically applied force, then differences would be simple to notice. A weight hanging on a string from the roof for example would not accelerate together with the box if an applied force were responsible for accelerating of the box, while the ball and string would accelerate along with the box if gravity were the responsible agent. There is no solid evidence for general relativity that is non-classical.

The notion is also mistaken that light has mass and is subject to gravity. The expression $E = mc^2$ reflects the fact that mass contains latent energy. This was proven directly with the atomic bomb where annihilated mass in a nuclear reaction causes the release of vast amounts of energy per gram of matter. Radiant energy from the sun likewise is produced from the annihilation of mass due to nuclear fusion reactions. And in reverse, the formation of mass when the universe of matter was Created must have been from the conversion of massive amounts of energy. However the formula is not a statement of congruence, and rather is a relation expressing equal magnitudes but not necessarily quality of energy. For example, the radiant energy from the sun's mass becomes fast traveling light photons, and light is not mass. And mass is not light. So the relation is being misused when one assumes that $m = E/c^2$ somehow proves that "light has mass." Likewise mass is not light, even though the relation was used properly by deBroglie to help prove that electrons with mass oscillate in orbitals around nuclei with wavelengths much like light has. Although the calculated deBroglie wavelengths for an electron in a hydrogen atom match the circumferences of orbitals in the hydrogen atom, mass is not light, just as light is not mass and is not subject to gravity as masses are. Light of course can be bent or refracted by the sun's corona matter, but gravity alone cannot act on light because light has no mass.

Recent photographs of a structure in deep space referred to as a black hole is not a hole. The belief is that material inside it is so dense that light is prevented from escaping it, but if matter is in its center then it is not a black hole, but rather a black body. And there is no proof that light is absent in it since light is invisible unless it is detected by either an eye or a camera. The object appears to block light behind it much like an eclipse, and there is no proof that light is swallowed into it, rather than either being extinguished by absorption or blocked forming a shadow. Again, gravity acts on masses, not light which is massless.

7. Nature of gravity

Earlier work [7] discussed the uniqueness of gravity that is distinct from electric or magnetic fields and from light. Gravity emanates from all objects with mass. Important characteristics of gravity are what it is not. Gravity is not energy, does not require loss of mass or loss of energy to exist around an object [8], is not a wave or a force, and is not spatially reducible. Gravity is an accelerating region in which masses produce a force. Gravity is not diffracted or reflected like light and is not attenuated or diminished by objects in its presence like electric fields are. Even a miniscule electron has gravity emanating around it because electrons have mass. Two neutrons separated by distance $\mathbf{r}$ have a gravitational force between them of $\mathbf{F} = Gm^2/\mathbf{r}^2$ where m is the mass of a neutron and G is the universal gravitation constant. There is no region in space around one neutron where the other neutron is able to escape the gravitation from the other. This is found by experiment and indicates that gravity should not be considered a force field characterized with field lines since this could imply that at some distance $\mathbf{r}$ from the mass that there could be a spatial position at that distance where that gravity might be absent.

Gravity intensity at a given distance from a mass is spatially irreducible. This is because even a miniscule electron senses its presence at any position at which it is located at a distance **r**. Pluto is a huge 6 billion km from the sun and nevertheless is smoothly turned by gravity at every position in its orbit, not only preventing its escape into space but also causing the tracing of an orbit that follows an elliptic mathematical function. Gravity is not reducible at any spatial position along the orbit. All planets in the solar system fall endlessly in perpetuity along elliptic paths in a dynamic equilibrium that is always striving to increase entropy while minimizing orbital energy [9]. Orbiting bodies around the sun instantly detect changes in gravity from the wobbling travel pattern of the sun even at great distances, which causes the bodies to change speed to travel in a smooth elliptic orbit. Galaxies in the universe may also behave in such a way, where each are gravitationally attracted to maintain order in the universe of matter where rotating galaxies maintain relative positions possibly in a dynamic equilibrium steady state.

8. Position is relative

The question, where are you?, requires context and relativity to answer. If the position of a person is desired in relation to the longitude and latitude coordinates on earth's surface, or in relation to a street address or city on earth, then an answer can be given because the spatial coordinate is provided in relation to a particular described position. However since the earth and all objects in the solar system are in constant motion, the true spatial coordinate of where one is located is not actually known with respect to a theoretic stationary 3-D (x, y, z) coordinate in space that one might refer to as an origin from which other coordinates may be measured and stated. And even if the entire universe of matter (as a whole unit) were not rotating or undergoing translational motion so that an origin point in space could be defined, the answer would also depend on time. Due to motion of the particular galaxy and solar system on which one might be located, the position one provides is technically only true at the particular time when the answer was given. The spatial coordinate is quickly changing while one provides the answer. Finally, the definition of you is also relative, where the position in space of the head is different than the feet or the body's center of mass, all at different elevations in 3-D space.

Figure 5 shows the position of the moon in perigee (at its closest approach to the earth) in relation to a tree on earth as a function of time. The moon shifts toward the tree about 5° of angular rotation in 20 min. This observation cannot distinguish whether the shift is caused by the orbiting motion of the moon (that does not spin), being accelerated while continuously changing its direction, or rather is due to either the spinning or to the orbiting motions of the earth. However, with extra data it is indeed possible to determine the major contributor. The moon orbits the earth and returns to its full moon position again in 28.3 days, at an angular velocity of 9.4 h



Figure 5.
Photographs of the full moon Feb 23, 2019 traversing behind a pine tree as time proceeds.

to shift 5°. The earth spins or rotates on its own axis 360° in 24 h, or 20 min for 5°, and thus is mostly responsible for the observed shift. In reality of course the actual observed shift is also affected by the fact that the moon and earth co-orbit around a common barycenter. In any event, the specific causes of effects that involve general relativity can indeed be determined by collection of additional information.

9. Nature of light

Unlike gravity that contains no energy itself, light is composed of individual photons of electromagnetic energy hf, formed from electrons that drop to lower energy levels in a source such as the sun, or a tungsten filament in a bulb, or a radio antenna. Light consists of orthogonal electric and magnetic field components that self-induce and self-annihilate rhythmically in perpetuity when uninterrupted. Thomas Young (1801) first demonstrated the wave nature of light which thus can undergo diffraction and interference and can be reflected, scattered, refracted, and absorbed by various media. Light in the visible frequency range is actually not visible to the naked eye. For example most light from the sun emanates into outer space and is not seen. Only light that reaches one's eyes is sensed. This means that anything assumed to be seen is actually a sensed image made by light reflected from the object at an earlier time. Since physical objects in the universe and on earth are always in a state of motion, objects are actually in a different spatial position at the time their light image is sensed. For example it takes 7.5 min for sunlight to reach the earth, so sunrise and sunset actually occurred 7.5 min before these events are actually sensed or "seen".

Photographs of light reflected from a candle prove that light emanates in all three dimensional space even though that light cannot be directly seen (**Figure 6**). The mirror reflects light directly toward the camera for detection from any position, reflecting light that was produced by the candle on the right while the light that exists on the left is invisible. The light on the left is made visible upon reflection by the mirror relocated on the left, while the original light that still exists on the right remains invisible.

Similarly, because light from sources such as stars propagates in all dimensional space even though it cannot be seen, distances to stars can be directly and conclusively determined by parallax. A star is at a particular time of night from an earth location positioned among background stars in shifted locations depending on the location of earth in its orbit. At summertime, the earth shown on the right in **Figure 7** detects light emanated from a star, while light from that star of course exists on the left but is invisible, being not reflected to the eye. In the winter when the earth is positioned on the left, the light is detected from the star while light on the right still exists but remains invisible. From the shifted relative position of the star between summer and winter, the distance to that star can be properly computed

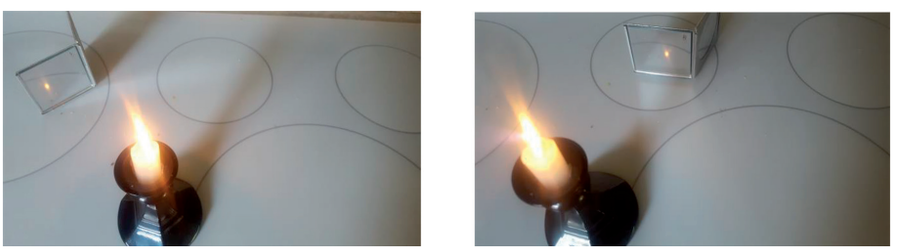


Figure 6.
Light from a source propagates in all directions in space but is invisible. It is sensed by either directly entering the eye (as seen here directly from the candle) or after reflecting the invisible light from the candle to the eye.

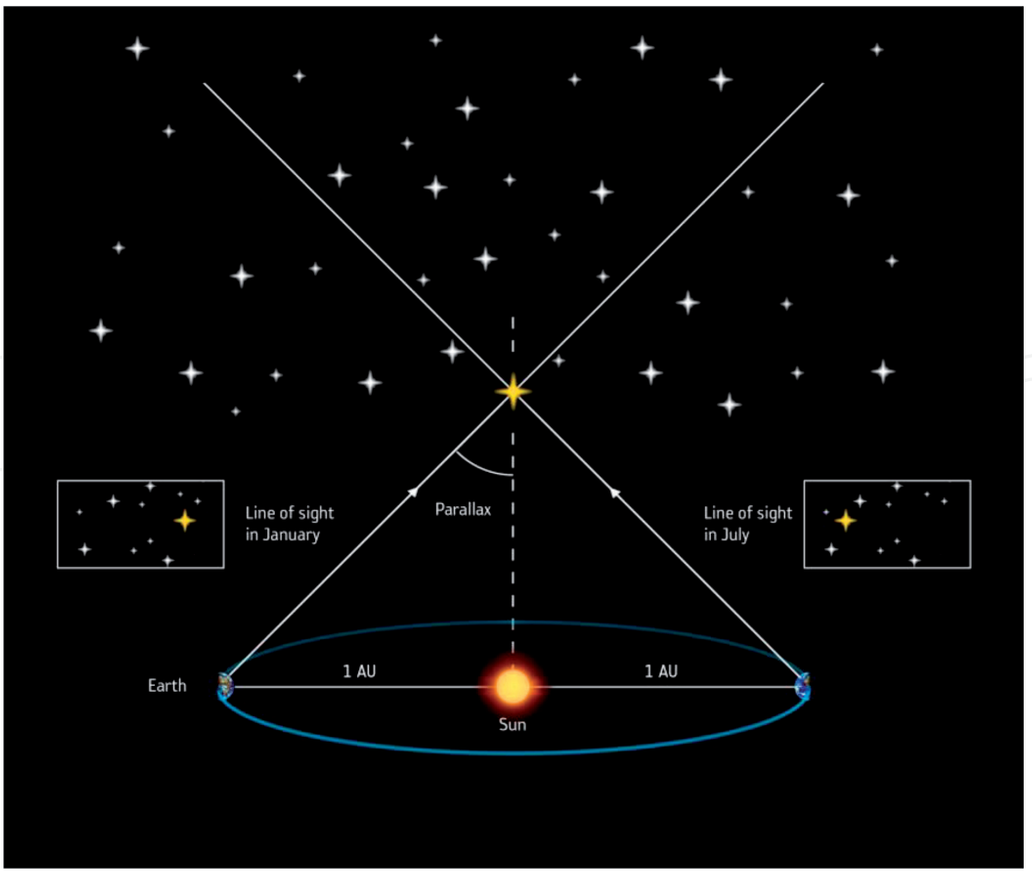


Figure 7.
Earth view of star in relation to distant background stars at summer and winter.

by triangulation. For example the secant of the elevation angle is **r**/(1 AU) where **r** is the distance from the earth to the star and 1 AU is 93 million miles. The picture is distorted intentionally for clarity, where the nearest star to the sun is the Alpha Centauri group at 4.37 light years away (25.6 trillion miles or 266,000 AUs) so that its elevation angle is actually greater than 89.9°. The farthest stars capable of being triangulated with modern space telescopes have a parallax angle so close to 0° that the distance is over 6000 light years. This means the these stars, where light is now arriving here on earth from them, must be at least as old as 6000 years and are at a distance of about 35 quadrillion miles from earth [(6000 years) (365 days/year) (24 h/day) (3600 s/h) (186,000 miles/s)].

Newton first proved in 1665 at Woolsthorpe Manor in England that light beams are actually composed of individual units he called corpuscles which we now call photons. Light has no mass since each photon must propagate in a given medium at a fixed speed c = E/B determined by properties of that medium. Photons speed up upon entering a more favorable medium and slow and retain that lesser fixed speed c in a less favorable medium. Photons follow one another in succession along a fixed bearing in cases where the light source is either stationary (which does not exist in nature since all galaxies rotate, and perhaps undergo translational motion and may vibrate with respect to each other over time, etc.) or moving in the direction photons propagate. Most light from either natural or artificial sources is actually composed of photons that are traveling in directions determined by the lateral motion of its source. This is because the first photon is emitted when the source is at location (x, y, z) but the next photon is produced when the source is at a slightly shifted location due to star or galactic motion. A laser light beam directed to a target while the source and target are in lateral motion consists of photons that traveled different paths to arrive at the

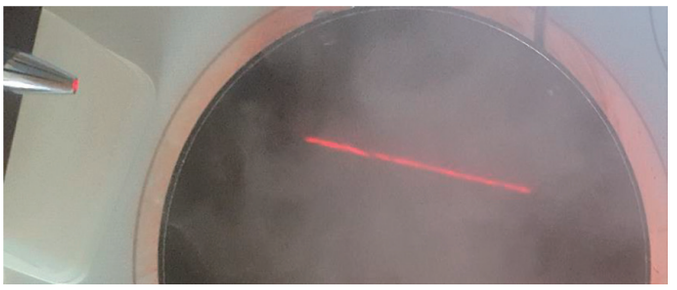


Figure 8.
A light ray made visible in a steam cloud. Over the distance of 0.25 m there are approximately 500,000 photons (= 0.25 m/500 × 10^{-9} m per wavelength) that illuminate the field in about 0.9 ns. Because the speed of the orbiting earth is small compared to light, each photon travels one after another forming a light ray where the paths of each successive photon essentially overlap. If the light source moved at near light speeds, the linear ray would be composed of photons having the same bearing but from shifted locations in space, where the photon arriving at the target on the right traveled the longest distance to arrive there, having left the source when at an earlier position. The photon on the left was produced last from the position where the source is now located. This is essential to understand why lateral moving light clocks do not prove that time dilates, but rather that travel distances for light depend on the relative motion of the source and target.

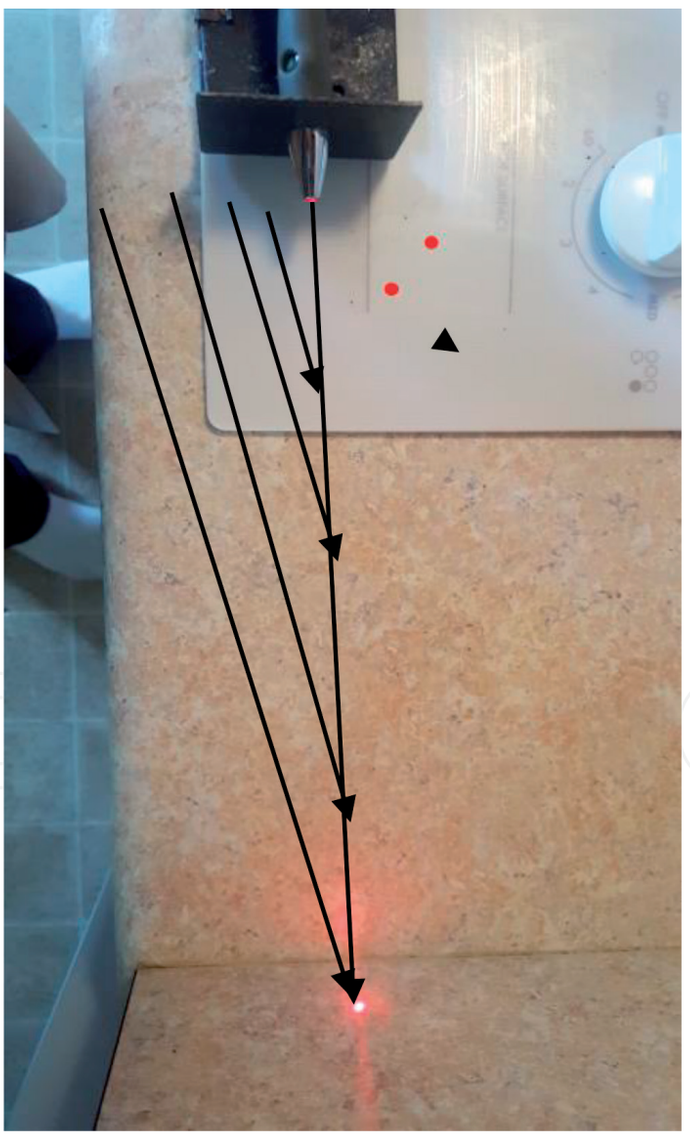


Figure 9.
Light produced by a lateral moving source actually forms a ray consisting of photons having slightly different travel path histories. Each photon departs from the moving source at different spatial coordinates. The photon shown arriving at the target actually left the source when it was at the leftward position. Photons produced from the source when the original photon arrives at the target are produced from the source in its pictured location and will arrive at the target when at its future shifted location further rightward.

shifted target because each photon departs from a different location during the lateral motion of the source [3]. A ray in a steam cloud (**Figure 8**) made continuously visible by reflection to an observer appears to have traveled in a direct, follow-the-leader path by an observer moving along with the source and target. A theoretic observer at some fixed coordinate could notice the actual travel path the photons all followed along linear but shifted diagonals if the source were moving laterally (if light could be made visible). Like an airplane that points at an angle skewed from a runway when a lateral wind is present, light photons would point toward a bearing other than the direction the ray follows. But since earth and planetary speeds are miniscule compared to that for light, this effect would not be observable but could be computed. Although Physics texts commonly claim that the illusion sensed by the moving observer means that time dilates for him, it is simply that a longer time is required for light to reach a shifting target, because the actual path traveled is determined by the photons, not the observer. Here each photon travels slightly further than 0.25 m because each leaves the source at propagation direction speed c from different coordinates, while forming a ray having a component velocity less than c [3]. The fact that photons in a linear ray would have distinct travel path histories if the source were moving laterally at near light speed (which is of course not actually possible for sources with mass) is diagrammed in **Figure 9**.

10. Intrinsic and relative velocity

From the photographs of the moon it is clear that the earth rotates on its axis 10° every 20 min. Since the earth latitude radius is 6372 km (3960 mi) in Southern California, then the tangential velocity of the observer due to earth rotation is $\mathbf{v} = \mathbf{r}\omega$ = 1036 mi/h. However the relative motion between the moon and earth do not detect the additional velocity of the earth and moon system that co-orbits with the sun around their common barycenter near the edge of the sun, at 30 km/s. Further, the rotation of the Milky Way galaxy must add to the total velocity of the observer, and it is very possible that the entire universe of matter exhibits a translational velocity while drifting through space although this is not known for certain. Therefore the actual velocity of the observer with respect to some stationary point from which it travels is far different than the particular velocity due to earth's rotation alone. In most cases the total velocity of objects with mass are not actually known with certainty. However, as is evident from the above discussion, for light which has an intrinsic speed in its propagation direction of constant c in a given medium, since physical motions of its source cannot alter light speed c, this means that light velocity with respect to its spatial point of origin is fixed and known. This is the intrinsic speed of light c. The intrinsic velocity of light however is relative to the direction in which it is desired to be used, where component intrinsic velocities of light have magnitudes that are less than c.

Moreover, relative speed and velocity are different from c for light when detectors (not sources) move toward or away from the light front. Otis first reported that detectors moving toward light in its propagation direction detect a higher frequency of light, while the source does not change the wavelength of the light produced and the intrinsic speed of light remains c [6]. Thus from velocity (in the propagation direction) $c' = f\lambda$, a higher (or lower) frequency causes a higher ($c' = c + \mathbf{v}$) (or lower, $c' = c - \mathbf{v}$) relative velocity c' between the detector and light front due to the velocity **v** of the source. The simplistic notion that light speed cannot be exceeded also needs to be clarified. Two light beams traveling in opposite directions illuminate space at speed 2c, while each beam propagates at fried intrinsic speed c,



Figure 10.
Palomar Community College Library Learning Resource Center, San Marcos, CA.

as shown by experiment earlier [2]. Further, evidence has been presented that changing gravity magnitude may be sensed between two distant masses at a speed greater than c [7, 9].

The new Palomar Community College library pictured in **Figure 10** is about 300 feet long situated East–West. The time required for light to travel from one end to the other if the earth were stationary would be about 0.3 ms. Since the earth travels this Eastward direction at 65,000 miles/h at midnight, the time required to reach the other end is longer by 0.03 ns because the library retreats from the light 9.2 mm Eastward while light traverses the building. Because the earth also rotates on its own axis, the time required would be 0.03 ns less at noon when the earth orbits Westward, like a twirling figure skater who also orbits a rink. Moreover, rotation of the galaxy plus any translational motion of the universe of matter would also alter the actual time. These effects seem small but nevertheless emphasize that all matter in the universe is in constant motion with variable velocity components, while massless light is fixed at propagation speed c from a stationary coordinate from which it departs. A ray travels speed c across the library but has a vertical component of velocity $\mathbf{v_y} = 0$. A ray shined upward would travel up at speed c with a horizontal component of velocity $\mathbf{v_x} = 0$, where light velocity, but not speed in its travel direction, varies from −c to 0 to +c depending on the direction of interest used in a problem.

11. Conclusion

To avoid misunderstanding or false conclusions, relativity must be considered for most questions asked in Physics. Christians are to be grateful for Creation, and gratitude is expressed here for gravity which keeps us from drifting into deep space, and for light that allows us to see.

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