Light's Presumed Constancy

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Abstract

It's widely held that light's velocity is fixed. It remains the same for everyone regardless of relative motion. Many believe Einstein proved this through special relativity's time dilation and length contraction for moving objects. But its relativistic effects only work in the one abstract dimension of linear motion. In our real nontheoretical world of three actual dimensions, light's perpendicular velocity would diverge from its forward velocity while exceeding 186,000mi/s. This glaring, unresolvable contradiction plainly demonstrates the conceptual impossibility of light's constancy. It simply has to compound with the motion of its source and that of other reference frames. This is easy to demonstrate. It's also clearly indicated by all of the Michelson-Morley type experiments and confirmed conclusively by Sagnac's. But we refuse to see it. Moreover, light's velocity is also variable. Its speed changes as it traverses the varying density of a gravity field. Einstein recognized this as well despite the nullifying conflict. But the problems with its constancy don't stop here. Both light's factual compounding and its variability have devastating consequences for relativity. They completely undermine its founding premise, which invalidates all of it, including its general theory as Einstein himself even concedes.

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Contents

Natural Law

In his book, *Relativity: The Special and the General Theory*, Einstein underpins his reasoning with his assumption that the speed of light is fixed everywhere for everyone regardless of their relative motion. Meaning that its velocity does not vary or compound with the motion of its source or that of other sources as we'd naturally infer. It's always 186,000mi/s.

This is relativity's founding premise that he continuously refers to as "law": "the simple law of the constancy of the velocity of light c (in vacuum)… this simple law... general law of nature, the law of the transmission of light *in vacuo*… the simple law of the propagation of light *in vacuo*... The law of the constancy of the velocity of light *in vacuo* [1]." (Use **[Alt][←]** to return.) And all of this is in only three pages. You get the feeling he wants us to accept that light's constancy is and has been for some time an established law of nature that's beyond reproach.

He doesn't offer a reason or an explanation why light's velocity is fixed. He just states that it is and everyone knows it, admonishing us that even, "Every child at school knows, or believes he knows, that [its] propagation takes place in straight lines with a velocity c = 300,000 km./sec... [which] is justifiably believed [2]."

He continues: "in the theory of relativity the velocity c plays the part of a limiting velocity, which can neither be reached or exceeded by any real body... the velocity of the transmission of light *in vacuo* has to be considered equal a constant c... The law of the transmission of light, the acceptance of which is justified by our actual knowledge... According to the theory of relativity, action at a distance with the velocity light always takes the place of instantaneous action at a distance... [special relativity's] results [that are dependent on light's constancy] hold only so long as we are able to disregard the influences of gravitational fields... [being] able to make use of space-time co-ordinates as four-dimensional Cartesian co-ordinates was possible on the basis of the law of the constancy of the velocity of light... the principle of the constancy of the velocity of light [is] valid only with respect to an inertial system [not a gravity field] [3]."

The point is, Einstein clearly believes light's velocity is fixed. And he wants us to believe it too. (A Cartesian coordinate system[1] is a two-dimensional rectilinear grid where any point can be specified with two numerical values [4]. Special relativity is, "the idea... [that] every motion must be considered only as relative motion... [where the] general laws of nature (e.g. the laws of mechanics or the law of the propagation of light *in vacuo*) have exactly the same form in [all] cases [5]." General relativity states that, "All bodies of reference... are equivalent for the description of natural phenomena (formation of the general laws of nature [mechanics and light's constancy]), whatever may be their state of motion [6].")

Light's Constancy

Einstein argues that relativity's particular application of the mechanical addition of velocities (the compounding of velocities but not what we'd naturally intuit) is necessary to prevent moving objects from attaining/exceeding the speed of light. Light's fixed velocity (mathematically) forces an object's (or reference frame's) time to slow and its contraction in the direction of motion (and the increasing mass of accelerating objects [7]). This is (theoretically) accomplished through use of the Lorentz[2] transformation (a system of equations Einstein adopted for relativity that translates the space and time coordinates from one reference frame to another [8]).

But relativity's adjustment to the mechanical compounding of velocities doesn't work. It's conceptually flawed. It only holds in the one abstract dimension of linear motion. In our real three-dimensional environment, it's inherently conflicted. Einstein seems to realize this, but after the fact. At one point, he surreptitiously slips in the (nullifying) qualifier "we then obtain the equation... which corresponds to the theorem of addition for velocities in one dimension according to the theory of relativity [9]."

1. Developed by René Descartes a French philosopher and mathematician, 1596-1659.
2. Hendrik Lorentz was a Dutch physicist, 1853-1928.

So it could be inferred that he may have been aware that it only worked in one dimension. If he was, why didn't he state it up front as a limiting qualifier? The most obvious reason is that it would have made all of relativity nothing more than a theoretical exercise that doesn't actually work in our real world. If he didn't fully comprehend the implications of its one-dimensionality, what does that tell you? But if he actually did and deceitfully maintained its feasibility anyway, that's even worse. So he's either delusive or deceptive. It has to be one or the other. Or it could be both. There's no way around it.

As evidence of relativity's validity as applied to the compounding of motion, Einstein cites Armand Fizeau's[3] experiment. We have to assume it's his famous 1851 experiment. He doesn't say. The way he characterizes it, Fizeau measured an increase in light's velocity when it's shone through flowing water in the direction of its motion as compared to when it's still. He interprets that rate of increase as better matching his formula than that of classic Galilean[4] mechanics (the physical relationships between force, matter, and motion where the basic laws of physics remain the same everywhere [10]).

But since in Fizeau's experiment there's no difference in motion between the light's source and the observer, a compounding of their velocities is not possible. They're of the same reference frame. So Einstein's employment of relativity to the addition of velocities theorem, even if it were correct, is not applicable.

What appears to be occurring is that the water first slows the light. Its speed in water is about 140,000mi/s. When it's flowing, it's then freed up to increase in the direction of flow. The issue seems to be that the increase does not appear to match the speed of the flowing water as expected. There could be any number of technical reasons for this that don't involve light's compounding.

The fact is, light has to mechanically compound with all relative motion. Its constancy is simply not possible. Nor is Einstein's application of relativity to the theorem of addition of velocities. This can be easily established with just ordinary, commonsense logic.

3. French physicist, 1819-1896.
4. Galileo Galilei was an Italian astronomer, physicist, and engineer, 1564-1642.

Light's Compounding

Imagine you're in one of Einstein's thought experiments riding a train with a flashlight that you're pointing directly forward. He'd have us believe that to maintain its fixed velocity, the speed of its light would be 186,000mi/s less the train's speed, that the train's rate of time would be running slightly slower, and that it and you would be physically contracting correspondingly but only in the direction of its motion all to satisfy his assumption of light's constancy. Most of us believe this to be true. It's our academic conditioning.

But what would happen if you then pointed another flashlight perpendicular (or at any angle) to its motion? With no contraction or motion in that direction, and with time's "slower" rate, that light's velocity would not only differ from the forward pointing light but it'd exceed 186,000mi/s, the universe's supposed maximum speed limit.

This common circumstance that's impossible to deny, which should be obvious to everyone but isn't, reveals the unresolvable conflict inherent in light's presumed constancy. Conceptually, in our real physical world of three actual dimensions, it cannot be fixed. It's mechanically required to compound with the motion of its source and that of other reference frames. This completely undermines any argument for its constancy. And without its underlying premise, relativity becomes untenable, in its entirety.

Let's just say, Einstein failed to perceive light's, and time's, innate three-dimensionality, but confined his reasoning only to the one abstract dimension of linear motion. How he got there and why he maintained its feasibility in three dimensions is anybody's guess. But it is worth considering. He does concede though that if it were found that light's velocity was not constant in all cases then relativity would out of necessity completely unravel [11]. (See **Figure 1.1**, Light's Constancy; **Figure 1.2**, Light's Compounding - next page)

1. STATIONARY

2. IN MOTION ➡
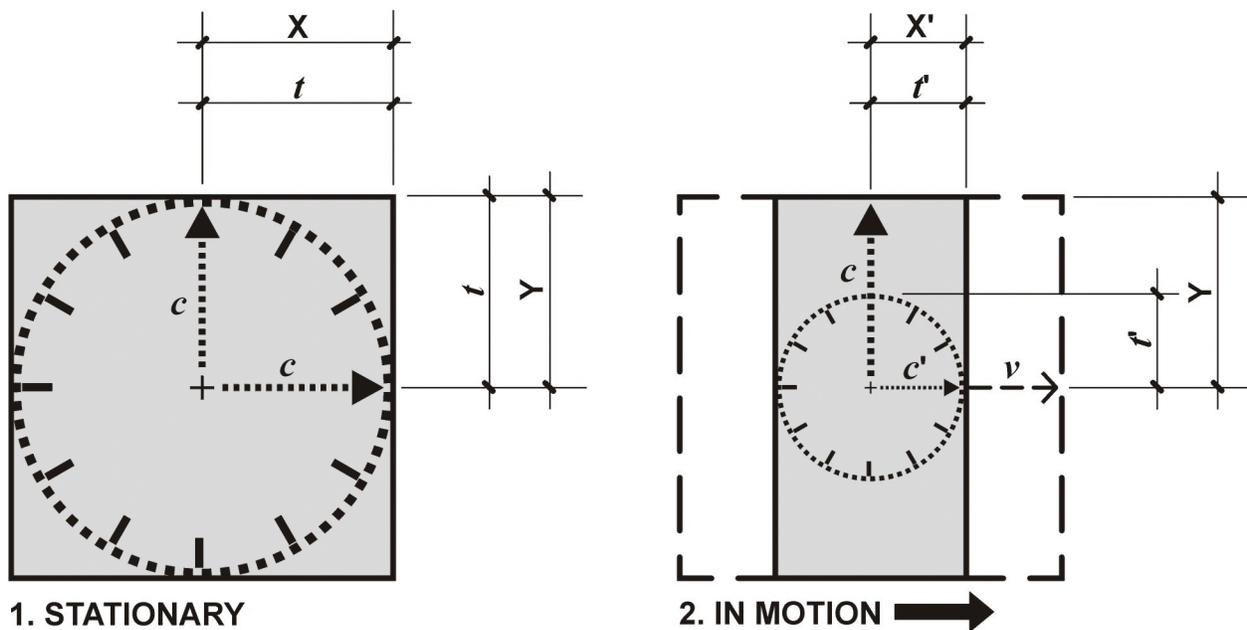
LIGHT'S CONSTANCY

A simple way to illustrate the impossibility of light's fixed velocity is by establishing a two-dimensional square reference frame, as depicted in diagram **1**, that could be of any size. When theoretically stationary, its **X** and **Y** dimensions from its center would correspond to light's constant velocity, indicated by the arrows at c, and time's constant rate, symbolized by the clock-like circle that fills the entire reference frame equally that equates to t.

It's important to establish at the beginning that in reality, there is no such thing as "time." It is not an independent property of the universe. Nor can it change with an object's motion. We define time by choosing an object with periodic motion to use as reference. The Earth's day and year are most common. So from the outset, light's assumed constancy enforced by a nonexistent time's slowing can have no validity and our discussion has to remain purely theoretical with no practical relevance. But let's go ahead anyway and demonstrate the fallacy of light's constancy as if time were real.
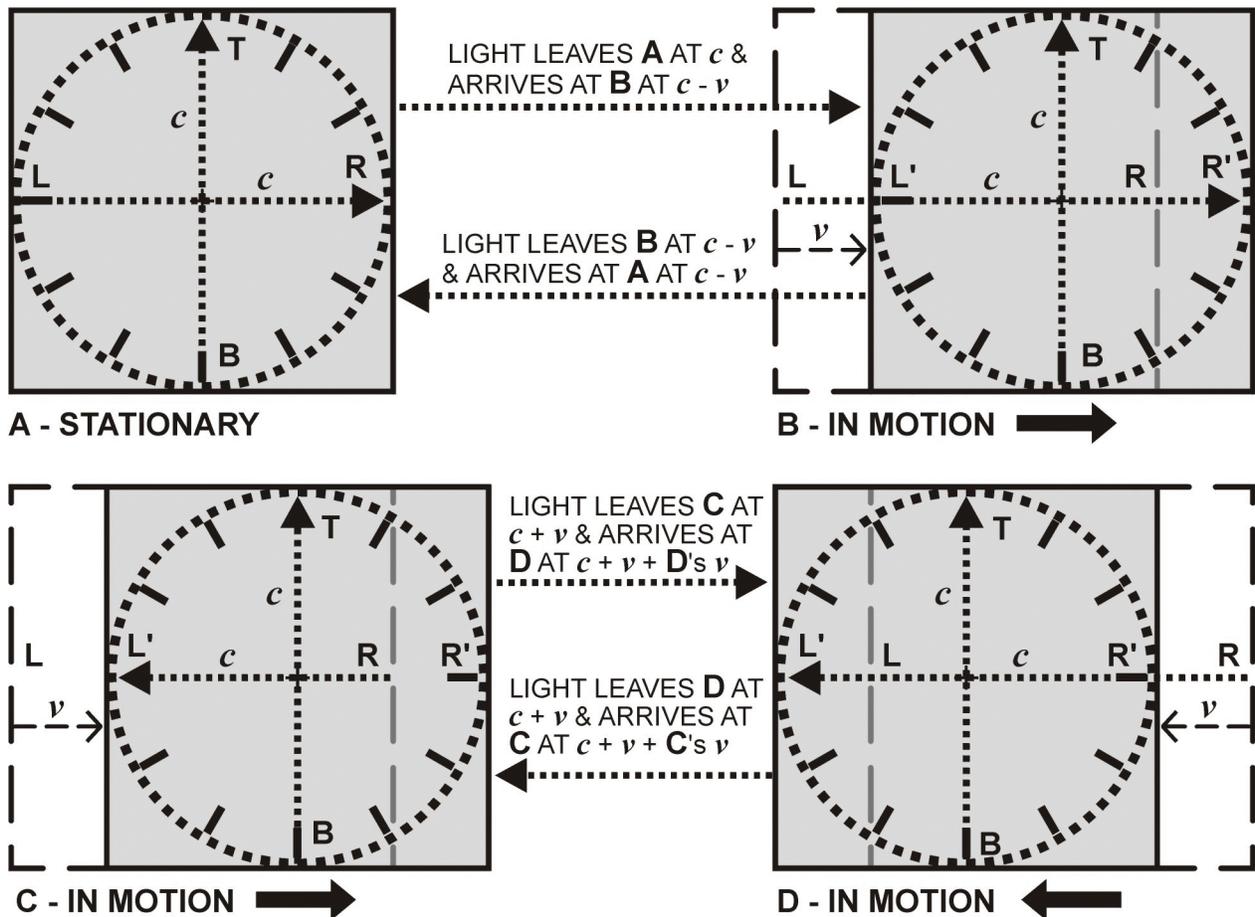
When our reference frame is put in motion, let's say moving from left to right at velocity v, as depicted in diagram **2**, for light's velocity to maintain its constancy in the direction of motion, it would have to slow in that direction by the amount of the reference frame's velocity to c'. This would require the reference frame to contract correspondingly in the direction of motion to the distance **X'** while its rate of time also contracted equivalently to t', as suggested with the smaller clock-like circle.

But since there's no motion in the perpendicular direction, our reference frame's **Y** dimension and light's velocity, c, are not required to contract to maintain its constancy. And since time's smaller rate, t', has to apply equally over the entire reference frame, this creates an unresolvable conflict in every direction other than directly forward, as indicated by the smaller clock-like circle. Its contracted time, t', corresponds to the contracted **X'** dimension and light's contracted velocity, c', in the direction of motion. But in the perpendicular direction, its contracted rate conflicts with the noncontracted dimension at **Y** and light's noncontracted velocity at c, which would cause it to exceed 186,000mi/s.

This clearly shows how light's velocity can only remain fixed, theoretically, in the one abstract dimension of linear motion. Even if time was an actual constituent of the universe, it's conceptually impossible in two or the three actual dimensions of our real nontheoretical world, which unequivocally affirms light's compounding with the motion of its source that in turn completely undermines every aspect of relativity by invalidating its underlying premise, light's constancy.

Figure 1.1

(3.1 Light's Constancy vi 6a)

A - STATIONARY

LIGHT LEAVES **A** AT c & ARRIVES AT **B** AT $c - v$

LIGHT LEAVES **B** AT $c - v$ & ARRIVES AT **A** AT $c - v$

B - IN MOTION ➡

LIGHT LEAVES **C** AT $c + v$ & ARRIVES AT **D** AT $c + v +$ **D**'s v

LIGHT LEAVES **D** AT $c + v$ & ARRIVES AT **C** AT $c + v +$ **C**'s v

C - IN MOTION ➡

D - IN MOTION ⬅

LIGHT'S COMPOUNDING

Light compounds with the motion of its source and that of other reference frames just as we naturally infer. The four conditions represent generic reference frames theoretically free of gravity fields to avoid light's variability. The clock-like circle in each symbolizes time's theoretical rate that remains constant throughout the entire reference frame. The dotted arrowed lines denoted with c indicate light's constant velocity at 186,000mi/s. The dashed grey lines indicate the reference frame's original location prior to motion.

Reference frame **A** is portrayed as theoretically stationary. For its observers, light moves from left to right and from the bottom to the top at c. An outside observer also theoretically stationary would record the same thing.

For reference frame **B**, it's depicted as moving from left to right with a velocity indicated as v. For those observers, light moves normally the same as if it were stationary from **L** to **R** and **B** to **T** at c. This is what's all of the Michelson-Morley and Sagnac type experiments show. Light always leaves its source at the same rate in all directions regardless of motion.

For an outside observer that's still theoretically stationary, light begins from its initial position at **L** and arrives at **R'**. Light travels a longer distance in the same amount of time. So its velocity exceeds c by **B**'s v. This is a compounding of velocities. Light projected between **A** and **B** also indicates its compounding as noted for the different directions.

For **C**, this time light is shown as projected from right to left, opposite the direction of its motion. Its observers again record the light's progress but this time from **R** to **L** as if stationary. But our stationary, outside observer records it traversing a shorter overall distance from **R** to **L'** in the same amount of time. This compounded velocity would be slower than c by **C**'s v.

D is the same as **B**, just in the opposite direction. The light projected between **C** and **D** indicates the compounding conditions for the other circumstances of relative motion.

Figure 1.2   (3.2 Light's Compounding vi 3a)

Michelson-Morley

Light's compounding is also clearly indicated by the well-known Michelson-Morley[5] experiment (1887) and all the others like it. It failed to establish the existence of an aether (a theorized universal medium that light was thought to propagate through [12]). What it did show was that the speed of light remained constant when comparing its velocity in the direction of the Earth's orbital (and rotational) motion to that in the perpendicular direction.

This demonstrates that light always leaves its source at the same rate in every direction at the same time. Einstein employed the Lorentz transformation to accommodate the negative results to calculate relativity's inferred contraction in the direction of motion to maintain light's presumed constancy [13].

The construct of their experiment basically consisted of two sets of mirrors perpendicularly arranged an equal distance from a central beam splitter in a cross fashion on a table that could be rotated so that a recombined beam of light would show an interference pattern if its velocity changed when aligned in the direction of the Earth's orbital (and rotational) motion [14].

To conclude from this experiment that light's velocity is fixed, as many do, is just not possible. The opposite is actually true. It plainly shows that whatever the source's relative motion, light always leaves it at the same velocity in every direction at the same time. This indicates a compounding of velocities, which suggests from an outside reference frame that every velocity for light has to be faster than the 186,000mi/s that we record here on Earth: 186,000mi/s plus the speed of the Earth's rotation plus the speed of its orbital motion plus the speed of our solar system through our galaxy plus the speed of our galaxy through the universe.
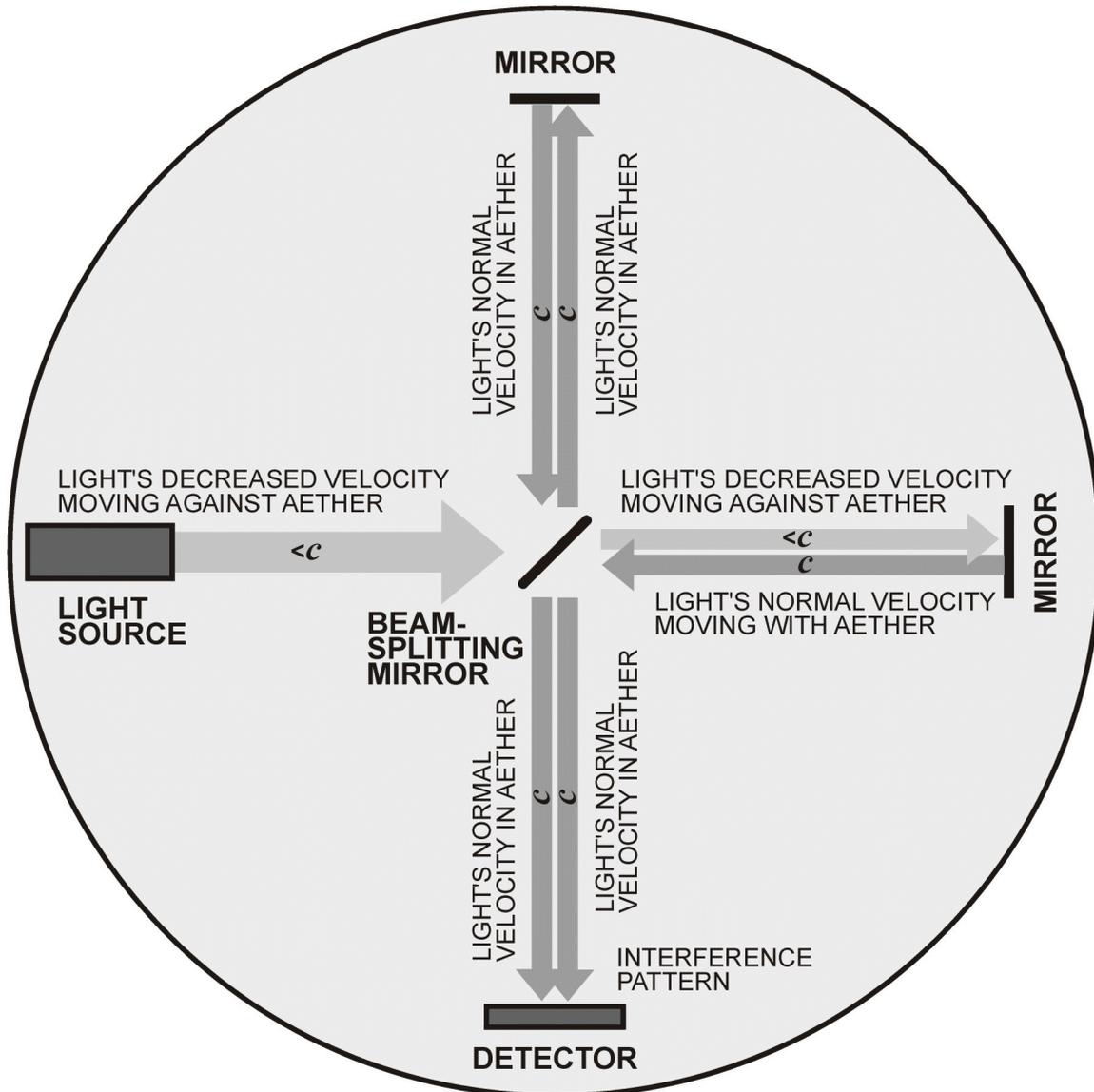
If the speed of light was actually fixed, its velocity in the direction of the Earth's rotation would be 186,000mi/s minus the Earth's rotational and orbital velocity that would be different from its velocity in the perpendicular direction, which should have produced an interference pattern but didn't. Our solar system and galaxy's motion would also have to be subtracted.

5. Albert Michelson, 1852-1931, and Edward Morley, 1838-1923, were American physicists.

Einstein concluded, along with others, that it's the experiment's contraction in the direction of (orbital) motion and time's corresponding "slowing" because of light's fixed velocity that's responsible for the negative result. But assuming "time" is something that actually exists and that its rate can actually change, its presumed "slower" rate, which would correspond to the experiment's contraction in the direction of motion, would have to be applied equally over the entire experiment along with the entire Earth. They're of the same reference frame.

And every reference frame can only have one rate of time. "Every reference-body (co-ordinate system) has its own particular time; unless we are told the reference-body to which the statement of time refers, there is no meaning in a statement of the time of an event [15]." With time's innate three-dimensionality but motion's one-dimensional direction, this causes light's velocity in the perpendicular direction, or any angle other than directly forward, to increase, giving rise not only to an unresolvable conflict between the two directions but a velocity for light that's supposedly impossible that exceeds 186,000mi/s.

This demonstrates that objects cannot be contracting in the direction of their motion. Nor can their time be "slowing." Which clearly indicates light's compounding with the motion of its source. (See **Figures 2.1**, **2.2**, **2.3**, **2.4**, Michelson-Morley - Conceptual Diagram; **Figure 3.1**, **3.2**, Michelson-Morley Experiment - 1, 2)

MIRROR

LIGHT'S NORMAL VELOCITY IN AETHER
LIGHT'S NORMAL VELOCITY IN AETHER

LIGHT'S DECREASED VELOCITY MOVING AGAINST AETHER

LIGHT'S DECREASED VELOCITY MOVING AGAINST AETHER

LIGHT SOURCE

$<c$

BEAM-SPLITTING MIRROR

$<c$
c

MIRROR

LIGHT'S NORMAL VELOCITY MOVING WITH AETHER

LIGHT'S NORMAL VELOCITY IN AETHER
LIGHT'S NORMAL VELOCITY IN AETHER

INTERFERENCE PATTERN

DETECTOR

DIRECTION OF EARTH'S ROTATION & ORBITAL MOTION ➡

MICHELSON-MORLEY - CONCEPTUAL DIAGRAM
EXPECTED RESULT

The experiment essentially consisted of a light source projected onto a series of mirrors arranged perpendicular equal distances from a central beamsplitter mounted on a rotating table oriented with one beam projected in the direction of the Earth's orbital motion and the other perpendicular. When the light was recombined, it was expected to produce an interference pattern due to its decreased velocity from the theorized aether "headwind." This would confirm the aether's existence. But no interference pattern was found.
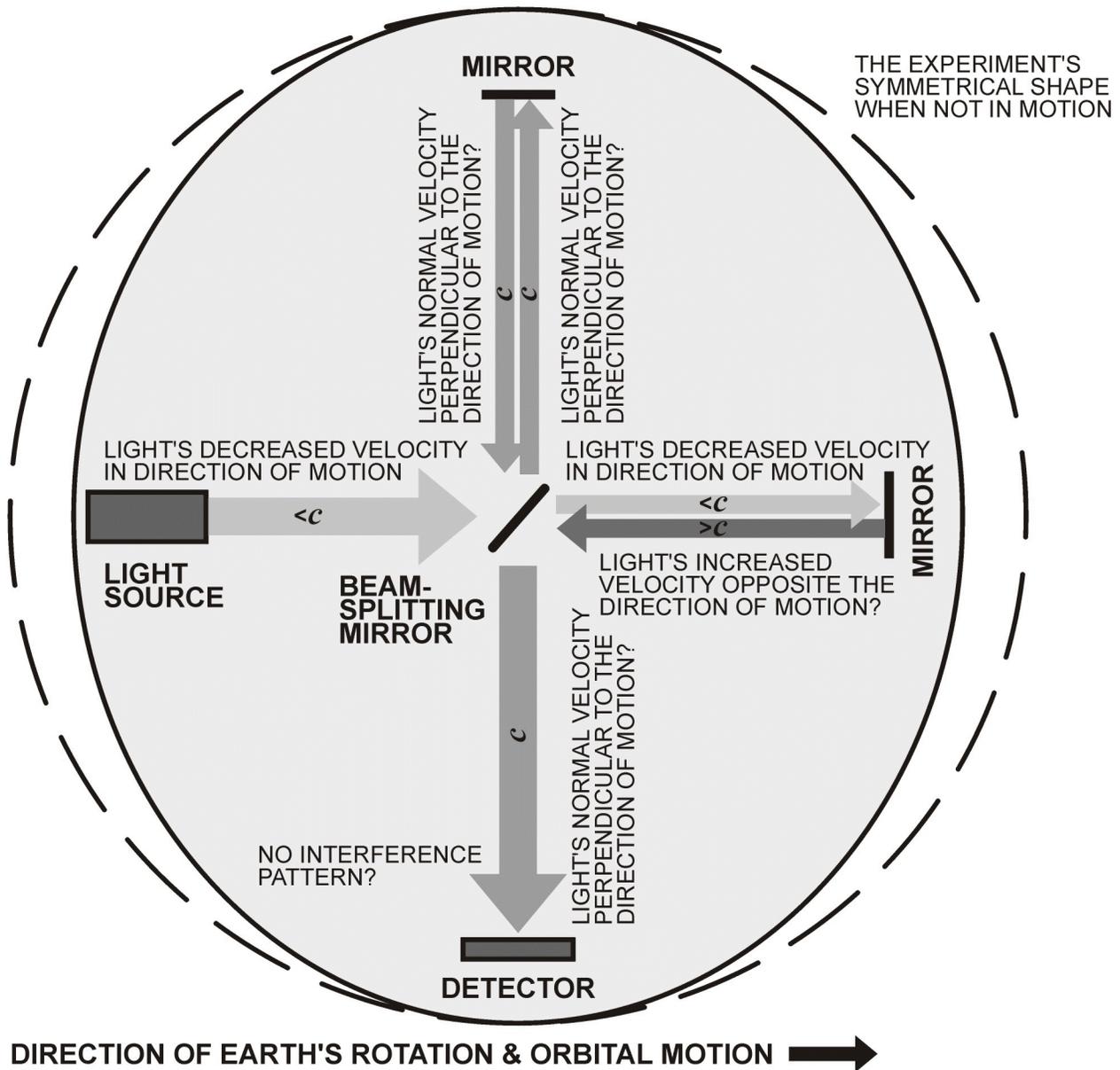
Figure 2.1

(1.1 M-M Exp vi 6a)
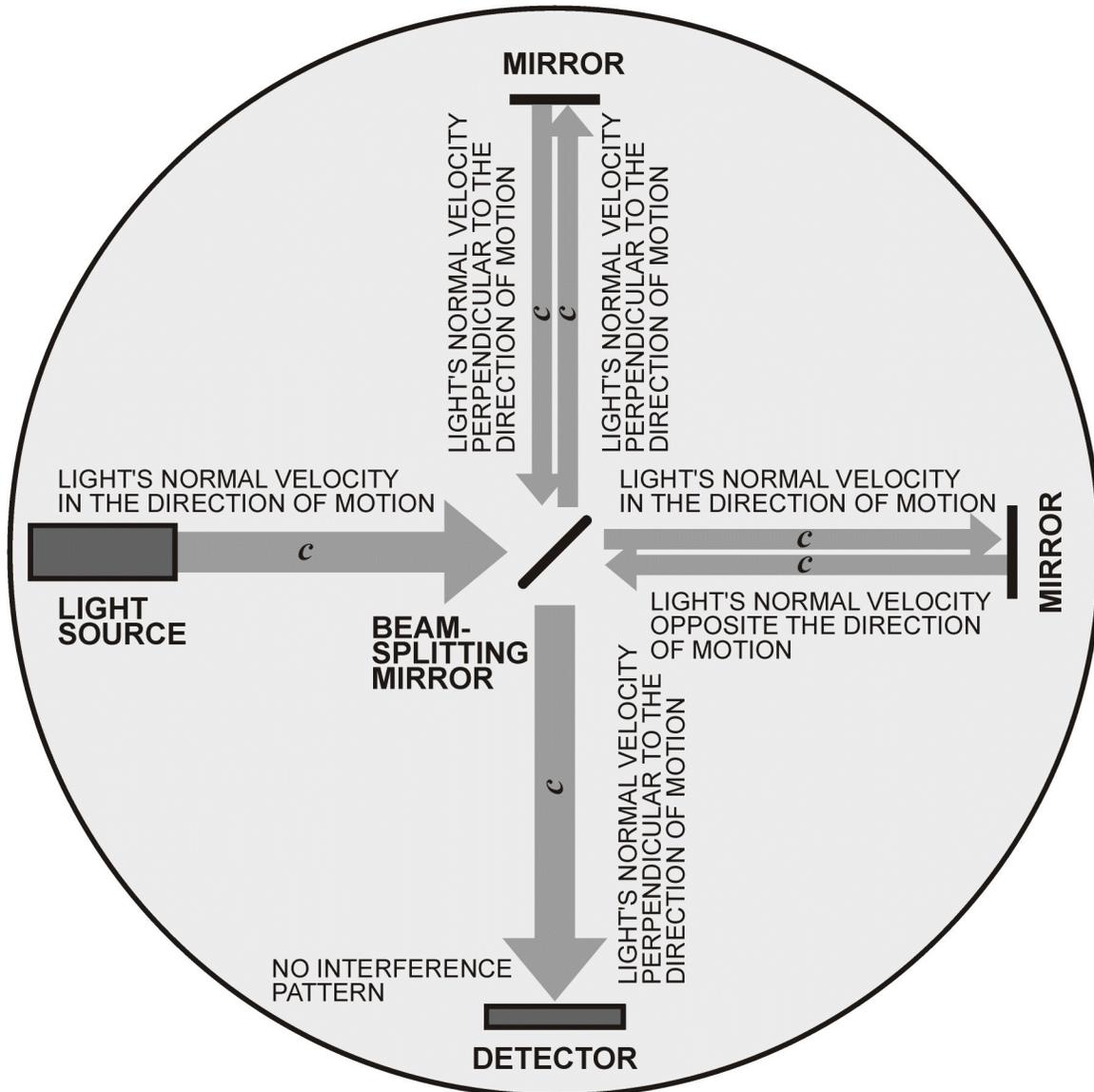
MICHELSON-MORLEY - CONCEPTUAL DIAGRAM

ACTUAL RESULT

What the experiment actually showed is that light always leaves its source at 186,000mi/s in every direction at the same time as we'd naturally expect. This indicates its compounding with the motion of its source and implies its compounding with other reference frames. Which means that because everything's in motion, its velocity can never be fixed at 186,000mi/s but will always be some slower or faster rate that can be any velocity up to instantaneous.

If someone was out in space stationary with respect to the solar system, they'd be in a different reference frame recording a compounding of light's varying velocity, which is determined by the field density at their location, plus/minus the Earth's rotational and orbital velocity or some vector angle of it.

**Figure 2.2**   (1.2 M-M Exp vi 6a)

MIRROR

THE EXPERIMENT'S
SYMMETRICAL SHAPE
WHEN NOT IN MOTION

LIGHT'S NORMAL VELOCITY PERPENDICULAR TO THE DIRECTION OF MOTION?

LIGHT'S NORMAL VELOCITY PERPENDICULAR TO THE DIRECTION OF MOTION?

c
c

LIGHT'S DECREASED VELOCITY IN DIRECTION OF MOTION

LIGHT'S DECREASED VELOCITY IN DIRECTION OF MOTION

$<c$

$<c$
$>c$

MIRROR

LIGHT SOURCE

BEAM-SPLITTING MIRROR

LIGHT'S INCREASED VELOCITY OPPOSITE THE DIRECTION OF MOTION?

c

LIGHT'S NORMAL VELOCITY PERPENDICULAR TO THE DIRECTION OF MOTION?

NO INTERFERENCE PATTERN?

DETECTOR

DIRECTION OF EARTH'S ROTATION & ORBITAL MOTION ➡

MICHELSON-MORLEY - CONCEPTUAL DIAGRAM
LORENTZ'S EXPLANATION ADOPTED BY EINSTEIN

What Lorentz proposed to explain the result, and Einstein later adopted for relativity, was that objects contract in the direction of their motion while time slows to maintain light's fixed velocity so that an interference pattern is not produced. But what happens to the experiment for the reflected light moving opposite the direction of motion? To maintain light's constancy wouldn't it have to expand while time's rate increased? And how about in the perpendicular direction? Without any contraction wouldn't time's "slower" rate cause light's velocity to exceed 186,000mi/s? These irresolvable conflicts confirm that light's velocity cannot remain fixed in our real nontheoretical environment of three actual dimensions but must compound with motion, which invalidates any Lorentz contraction and undermines nearly all of relativity.

**Figure 2.3**

(1.3 M-M Exp vi 6a)
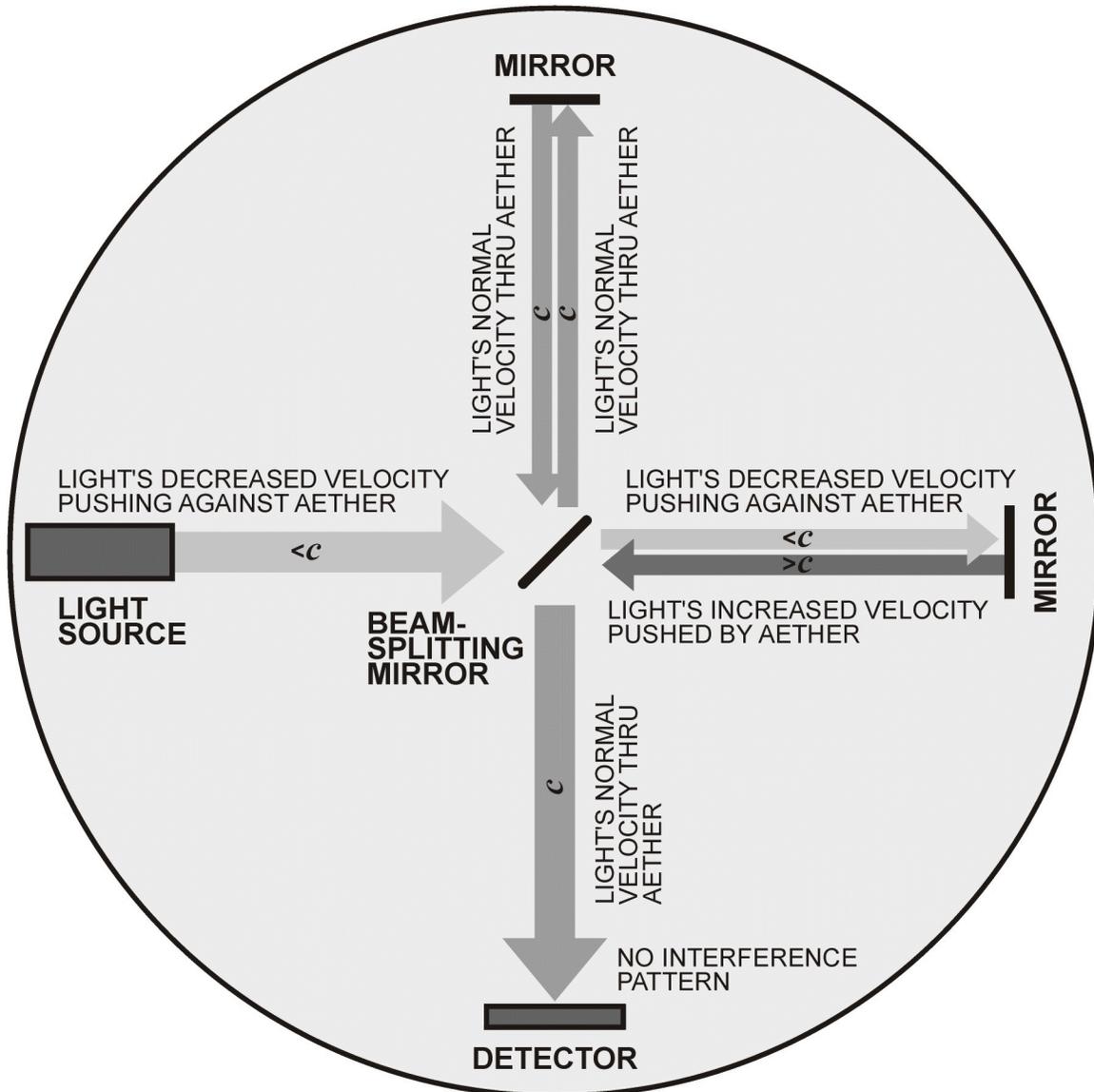
DIRECTION OF EARTH'S ROTATION & ORBITAL MOTION ➡️

MICHELSON-MORLEY - CONCEPTUAL DIAGRAM
AETHER EXPLANATION

Instead of contriving the fantastic, self-conflicted notion that objects physically contract but only in the direction of motion while time's rate slows to maintain light's constancy, why wouldn't you simply reason that light's velocity is first slowed by the aether's "headwind" then is increased by the same amount from its "tailwind" after it's been reflected backward? It's not the correct explanation. But at least it's rational.

Figure 2.4

(1.4 M-M Exp vi 6a)

1. EQUATORIAL VIEW **2. POLAR VIEW**
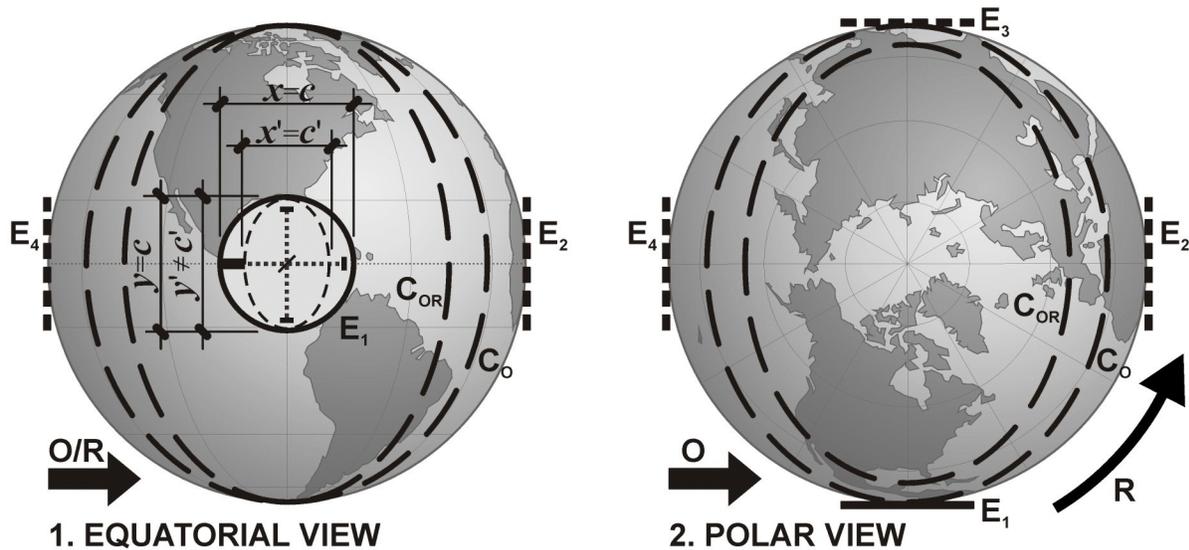
MICHELSON-MORLEY EXPERIMENT - 1

The experiment essentially consists of several mirrors arranged rectilinearly in a cross pattern around a central beamsplitter on a table that can be rotated. For simplicity, ours is at the equator, E_1. It showed that light, c, always radiates at the same rate in all directions at the same time regardless of motion. The arrow at **O/R** indicates the direction of the Earth's orbit & rotation. At **O**, its orbit. The curved arrow at **R** indicates the direction of its rotation. For our purposes, we can ignore the motion of our solar system and galaxy.

Einstein assumes that light's velocity is fixed. It's (special) relativity's basal premise. So objects have to contract in the direction of motion while time's rate slows correspondingly to maintain its constancy. That's how he explains the experiment's result.

So in the direction of its orbital motion, the Earth would have to contract into an ellipsoid shape, indicated by the dashed ovals at C_O. Its rotation would also cause its ellipsoidal contraction. The combination of both is represented by the dashed ovals at C_{OR}.

As the experiment revolves around the Earth, this would cause it to contract in the x direction, as implied by the dashed oval at E_1, which decreases the distance between the mirrors while time's rate slows to maintain light's constancy (assuming "time" is something that actually exists and that it slows with motion). In the y direction, there is no motion. So there's no contraction. The distance between the mirrors remains the same.

Since time's slower rate has to apply equally over the experiment (and over the entire Earth, they're of the same reference frame), it affects light's velocity, c', the same in both the x and y directions. But with contraction only in the x direction, not in the y, this creates different velocities for light. y' will always be faster than x'. This would cause different arrival times, which should have produced a negative interference pattern. But it didn't.

For the Earth's contraction from its orbital motion, the distance between the mirrors in the y direction would also remain unchanged, while the distance in the x direction would be constantly fluctuating. The Earth's rotation would pass the experiment through its orbital tangents, causing maximum contraction at E_1 & E_3 with no contraction at its perpendicular positions, E_2 & E_4, which would compound with its constant contraction from its rotation. The result would be C_{OR}. This should have also produced a negative interference pattern, but one that was expanding and contracting every twelve hours. But this didn't happen either.

Einstein also asserts that special relativity's effects can't occur within gravity fields where light's velocity varies. But the experiment rests in the Earth's gravity field, and all others. They extend indefinitely. So how can it even be considered to explain the results?

The experiment clearly demonstrates that objects do not contract in the direction of motion. Nor does (nonexistent) time slow with motion. So its velocity can't be fixed. It compounds with the motion of its source and that of other reference frames, and that's in addition to its variability. With a founding premise that's untenable, relativity has no viability.

Figure 3.1   (16.1 MM vi 7a)

1. REALITY:
LIGHT'S COMPOUNDING
TIME IS NONEXISTENT

2. EINSTEIN:
LENGTH CONTRACTION
TIME DILATION
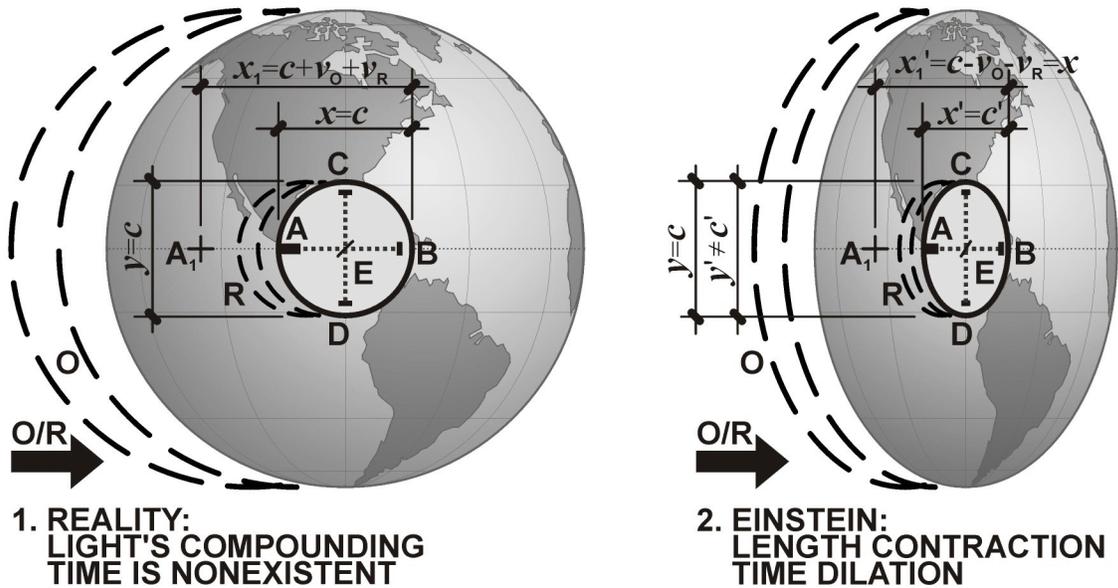
MICHELSON-MORLEY EXPERIMENT - 2

Light always radiates at the same rate in all directions at once regardless of the motion of its source. So someone at the experiment, E in diagram **1**, measuring light's velocity from A to B, distance x, and also from C to D, distance y, would get 186,000mi/s in each direction, $x=c$ and $y=c$, despite their motion. They're of the same reference frame, moving in unison with the Earth's orbit and rotation, implied by the dashed ovals at O and R.

If we positioned ourselves just outside the Earth's orbit, stationary with respect to the solar system, which is a different reference frame, we'd see that the measurement they made in the x direction actually covered a longer distance from A_1 to B, distance x_1. But for them, they still measured from A to B, covering the shorter distance x due to their motion.

If we measured light's velocity from A to B as the Earth sped by, our measurement would also begin at A_1 and end at B. But light would traverse the longer distance, x_1, in the same time it took for it to go from A to B, distance x, for the person at E because we're not moving with the Earth. So for us, light's velocity would have to include the Earth's orbital velocity, v_O (66,000mph), and its rotational velocity, v_R (1,000mph). Their compounded velocities over distance $x_1=c+v_O+v_R$. That works out to be about 186,020mi/s.

With his underlying assumption that light's velocity is fixed regardless of motion, Einstein reasons that time slows for moving objects while their length contracts to preserve light's constancy. So for the Earth, light's velocity has to decrease by its orbital and rotational velocity, v_O and v_R (excluding our solar system and galaxy's motion), while time's rate has to slow and the Earth has to contract correspondingly, along with everything else in its reference frame, in the direction of those motions, as portrayed in diagram **2**. The distance x_1' has to contract to distance x to maintain light's constancy where $c'=c-v_O-v_R$.

But "time" doesn't actually exist. It's not a property of the universe. So there's nothing there to slow with motion. And even if it did exist, its rate wouldn't slow. It'd increase. A unit of time, like a second, that corresponded to distance x that was theoretically contracted to the shorter distance x' would be a faster second. Compressed "time" is a faster running "time."

Einstein also "ignores" light and time's innate three-dimensionality. Time's changing rate and length's contraction only work in the one abstract dimension of linear motion. In the three actual dimensions of our real environment, they're inherently conflicted. There's no motion in the y direction. So there's no contraction. y' and x' can never be the same length. But time's "slower" rate still has to apply in the y direction. It's the same reference frame. So light's velocity can never be the same. y' 's will always exceed x' 's. This invalidates Einstein's basal premise, which undermines relativity in its entirety, and that's without even considering his contradictory but correct assertion of light's variability that does so as well.

Figure 3.2

Sagnac

Sagnac's[6] experiment also confirms light's compounding with motion but more succinctly. He devised an experiment in 1913 that he thought would prove the existence of an aether, while also disproving special relativity. He believed he succeeded.

The construct was not that dissimilar from Michelson-Morley's. In concept, it essentially consisted of a source that sent light through a beam splitter that separated it in opposite directions, routing it to several mirrors located around the perimeter of a rotating platform that formed the corners of a closed loop that returned the light back to its entry point where the recombined beams would create an interference pattern if their velocities were different. The primary difference from Michelson-Morley's was the closed loop [16].

When the platform was not rotating, no interference pattern was observed. The light took the same amount of time to reach the detector in each direction despite all of the Earth's motions (its rotational and orbital, our solar system's motion through the galaxy, and our galaxy's motion through the universe). This was the same result as Michelson-Morley's.

When it was rotating, the recombined beams did produce an interference pattern. Sagnac concluded that light's velocity is independent of the motion of its source. That's actually not correct. Light always leaves its source at 186,000mi/s in all directions at the same time. That makes it very much dependent on its source. Its velocity always gets added or subtracted to its source's velocity and that of other reference frames. It compounds. His and Michelson-Morley's experiment clearly demonstrate this.

When the platform is not rotating, the light departs its source at 186,000mi/s and it remains the same in both directions after it's split. The moment it leaves its source, its motion defines it as a different reference frame. But it's moving in unison with the platform (and the platform is moving in unison with the Earth). There's no compounding of velocities. So the light in both directions reaches the detector at the same time and no interference pattern is created.

6. Georges Sagnac was a French physicist, 1869–1928.

When the platform is spun, light's velocity is compounded with its rotation. This is what's responsible for the interference pattern. The light still leaves its source at 186,000mi/s, and it still acts as an independent reference frame. But the platform's rotational or angular velocity, ω, is added/subtracted to the light's velocity.

When the light gets split in opposite directions, it in essence creates two different reference frames from the initially emitted light. The light split in the forward direction travels at $c+\omega$. The light split to the rear travels at $c-\omega$. Both beams reach the detector at the same time. But their different velocities cause them to be out of phase. So an interference pattern is created.

Another way to express the same idea is that a Doppler shift (a change in frequency due to the motion between a source and an observer [17]) occurs between the two beams. The forward split light's faster compounded velocity causes it to be slightly blueshifted relative to the rearward light. Or the other way around, the rearward split light's slower compounded velocity causes it to be slightly redshifted as compared to the forward split light. Any way you look at it, their relative shift in wavelength has them out of phase at the detector, which produces an interference pattern.

In another one of his many invalidating contradictions, Einstein apparently came to the same compounding-of-velocities conclusion when investigating the effect. He decided that for accelerating frames of reference "the principle of the constancy of light must be modified [18]." In other words, it doesn't work and needs to be scrapped.

The most common explanation for the Sagnac effect does not incorporate a compounding of velocities. It never addresses the emitter and beamsplitter's constant rotational velocity that would normally be imparted to its light. It's just ignored. This causes different arrival times that produce an interference pattern.

But light always leaves its source at 186,000mi/s in all directions at once. Michelson-Morley and Sagnac, when not rotating, definitively establish this. And every source is in motion. So that motion has to be accounted for. Either it's compounded with light's velocity or it, time, and length have to be metaphysically altered similar to how special relativity dilates time and contracts length.

But special relativity fails completely as an explanation of the effect for both the rotating and nonrotating conditions. It's inherently flawed. Conceptually, it can only address an environment in one dimension, the direction of motion. In every other direction, it's insurmountably conflicted [19].

For the nonrotating condition, light's velocity in the perpendicular direction (or at any angle other than directly forward) would be greater than the forward direction, exceeding 186,000mi/s. Time dilation's innate three-dimensionality and length's one-dimensional contraction can maintain its fixed velocity only in one dimension, the direction of linear motion.

In the other two dimensions of our real world, it's unworkable. Light's velocity would contradictorily be increasing. If relativistic effects were actually feasible, they'd create conflicting velocities that'd produce an interference pattern for the nonrotating condition just like what was demonstrated in the diagram for Michelson-Morley.

For the rotating condition, special relativity would theoretically compound the platform's rotational velocity with light's velocity. But it enforces the assumption of light's constancy by reducing its velocity by the amount of the rotational velocity in the forward direction and increasing it by the same amount in the rearward direction. This maintains light's fixed velocity and produces the same result, different arrival times that create an interference pattern.

But relativistic effects always produce the same contradictory results. The spinning platform's time is required to slow. It's one reference frame. While its perimeter around its circumference is required to contract. But its interior does not. Its radius remains the same [20]. That's not possible.

Moreover, Einstein asserts that, "The special theory of relativity [is only valid where] no gravitational field exists" because of light's variability in them [21]. (More on light's variability in gravity fields shortly.) So if his "principle of equivalence" (where acceleration/braking and rotation create gravity fields the same as natural, mass-created gravity [22]) were actually true and rotation's centrifugal force actually did produce real gravity then light's constancy, time's dilation, length's contraction, and the increasing mass of accelerating objects cannot even be considered as an option to explain the Sagnac effect. Its associated rotation would be producing centrifugal gravity where light's velocity varies, which would preemptively nullify its constancy and special relativity's relativistic effects.

Trying to explain the results through his "principle of equivalence" doesn't work either. It's also entirely unfeasible. Light's slower velocity in the rotating experiment's centrifugal gravity field would presumably account for the disparity that causes the interference pattern. But it can be easily shown that rotation doesn't create gravity. So Einstein's "principle of equivalence" isn't an option.[7]

Relativity's simultaneity has also been proposed as a possible explanation. But it also doesn't work. It's fundamentally flawed as well. Any factual review quickly reveals its obvious failure in logic. But it also requires too much off-topic background for this discussion. A cursory but objective investigation will certainly be enough for those seeking further explanation [23]. (See **Figures 4.1**, **4.2**, **4.3**, **4.4**, Sagnac Effect - Conceptual Diagram)

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7. For more on equivalence see: "Equivalency's Fallacy," viXra open-access archive, May 13, 2023, http://vixra.org/abs/2305.0102.

DIRECTION OF THE EARTH'S ROTATION & ORBITAL MOTION ➡️
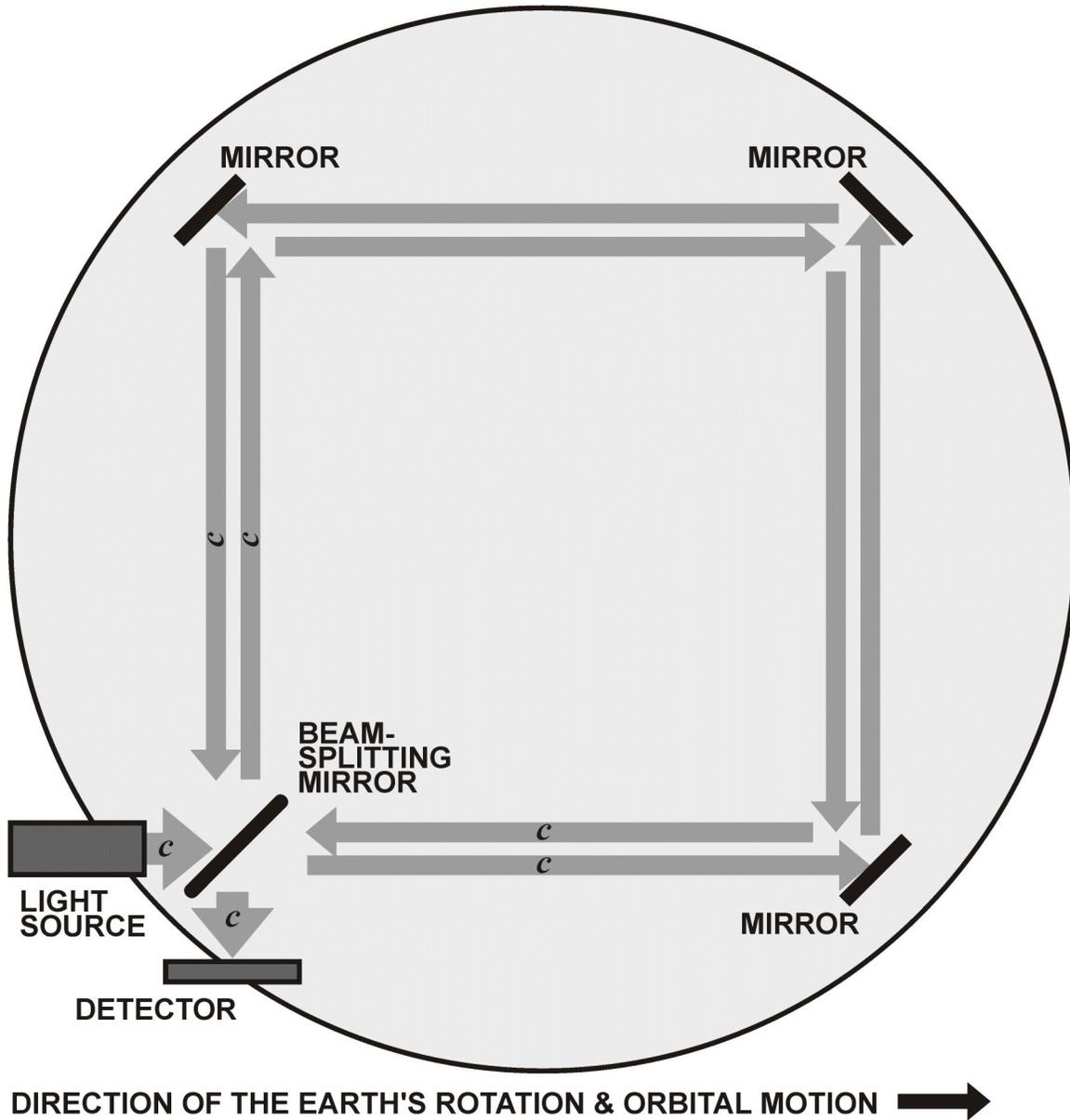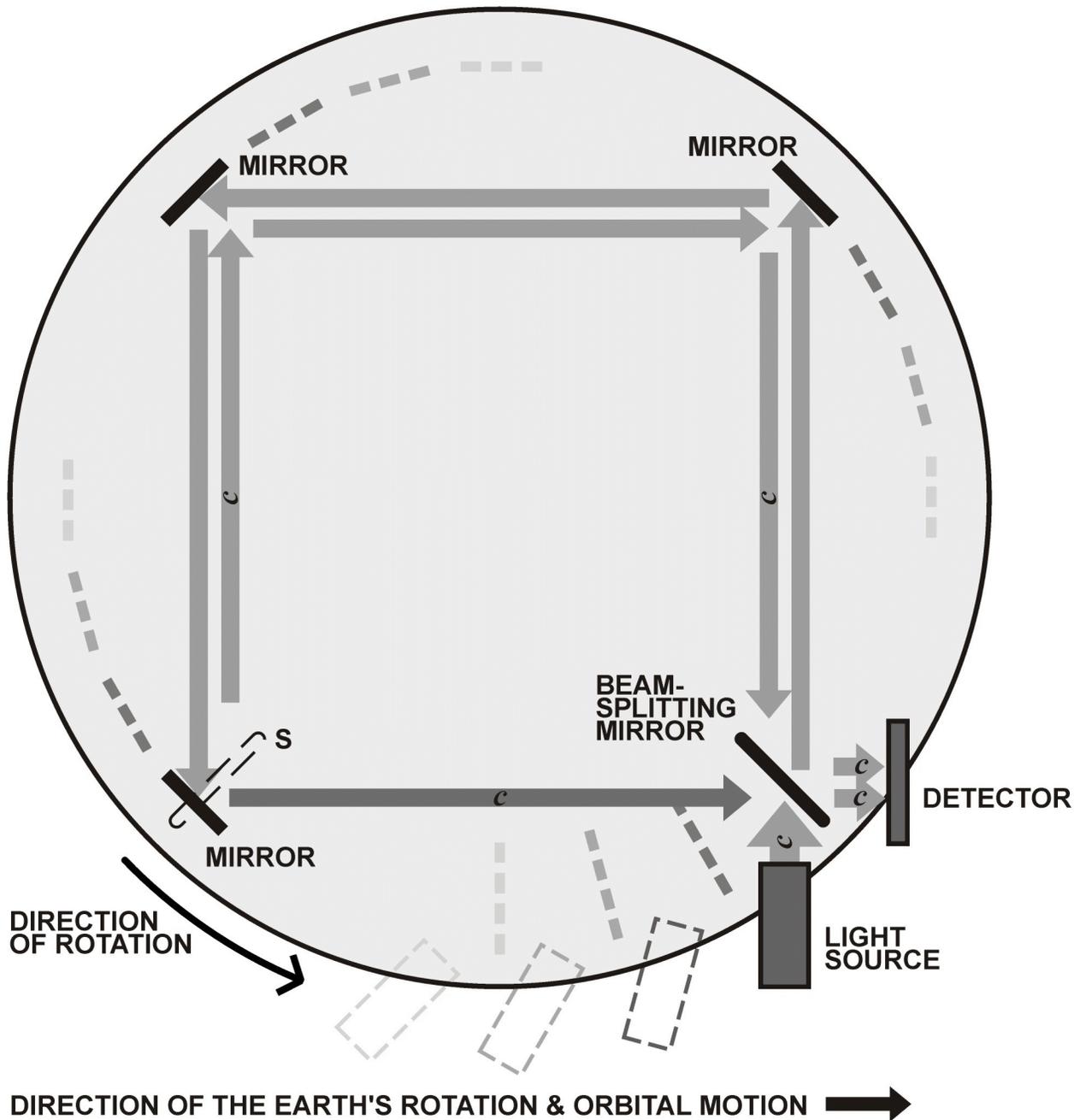
SAGNAC EFFECT - CONCEPTUAL DIAGRAM
NO ROTATION

Sagnac's experiment essentially consists of a source of light that's projected onto a beamsplitter that sends it in opposite directions around a series of mirrors arranged in a closed loop at the perimeter of a platform form that can be spun that recombines the beams back at a detector, as suggested by the grey linear arrows labeled as c that indicates light's velocity. The inside row of arrows indicates light's clockwise path. The outside counterclockwise.

When the platform is not rotating, no interference pattern is produced. This is essentially the same result as the Michelson-Morley experiment. Both show light always leaving its source at 186,000mi/s in all directions at the same time. Light's independent motion could qualify it as a separate reference frame. Because the platform and the light it's emitting move with all of the Earth's motions, rotational and orbital, our solar system's motion through our galaxy, and our galaxy's motion through the universe, this suggests light compounds with the motion of its source and that of other reference frames.

Figure 4.1   (49.1 Sagnac Exp vi 5a)

DIRECTION OF THE EARTH'S ROTATION & ORBITAL MOTION ➡️

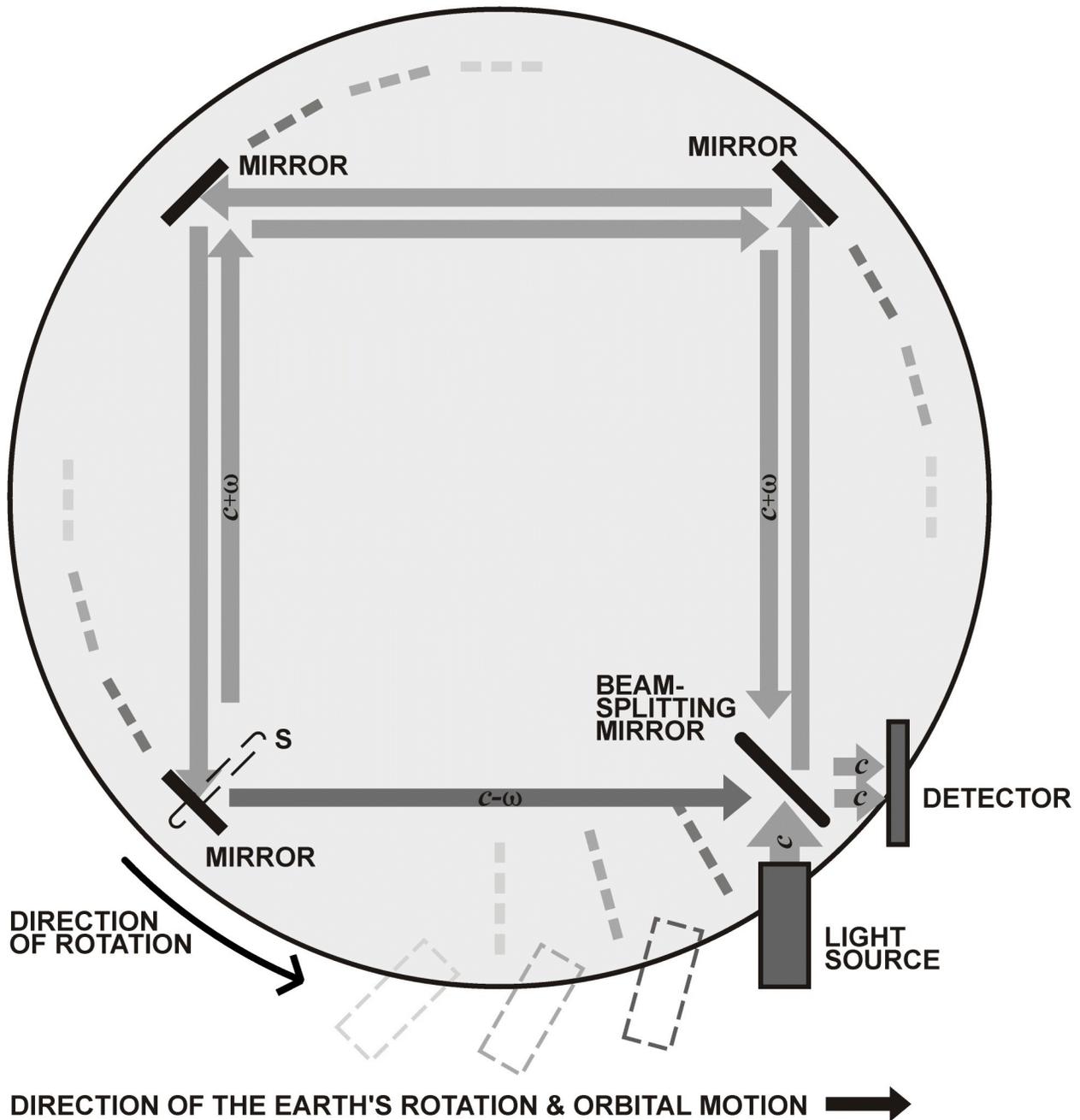## SAGNAC EFFECT - CONCEPTUAL DIAGRAM
WITH ROTATION - ORTHODOXY

The interference pattern produced when the platform is spun has several possible interpretations. For convenience, let's establish the platform's rotation as constant with an angular velocity that completes one-quarter rotation for three-quarters of light's.

The conventional explanation assumes that the light still leaves its source at 186,000mi/s and is split from **S** at the same velocity in both directions. It's thought that because the platform is rotating into it, the rearward split light arrives at the detector first, which for our diagram is 3/4 of one revolution. While the forward split light arrives later, in 11/4 revolutions, the overlap indicated by the darker arrow. The difference in arrival times would produce a phase shift that creates an interference pattern.

Sounds reasonable enough, but it's inherently flawed. It fails to account for the platform's constant rotation. It departs from it at 186,000mi/s as if there were none.

Figure 4.2   (49.2 Sagnac Exp vi 5a)

MIRROR

MIRROR

$c+\omega$

$c+\omega$

BEAM-
SPLITTING
MIRROR

S

$c-\omega$

c
c

DETECTOR

c

MIRROR

LIGHT
SOURCE

DIRECTION
OF ROTATION

DIRECTION OF THE EARTH'S ROTATION & ORBITAL MOTION ➡

SAGNAC EFFECT - CONCEPTUAL DIAGRAM
### WITH ROTATION - SPECIAL RELATIVITY

Special relativity does account for the platform's rotation. But it doesn't work either. The split light would leave at $c-\omega$ in the direction of rotation and $c+\omega$ opposite the direction of rotation to maintain light's fixed velocity. The light would arrive at the detector at different times because of the platform's rotation, creating an interference pattern.

But special relativity is inherently self-conflicted. It would have the platform's perimeter contracting while its radius remains constant and its time dilates for the entire platform. That's not even remotely feasible.

It would also conflict with the results when the platform is not rotating. It would have to be contracting in the direction of the Earth's motions to enforce light's constancy but not in the perpendicular direction while time's slowing would again have to be applied equally over the entire platform. It's one reference frame. So it fails in every respects.

Figure 4.3

(49.3 Sagnac Exp vi 5a)

DIRECTION OF THE EARTH'S ROTATION & ORBITAL MOTION ➡
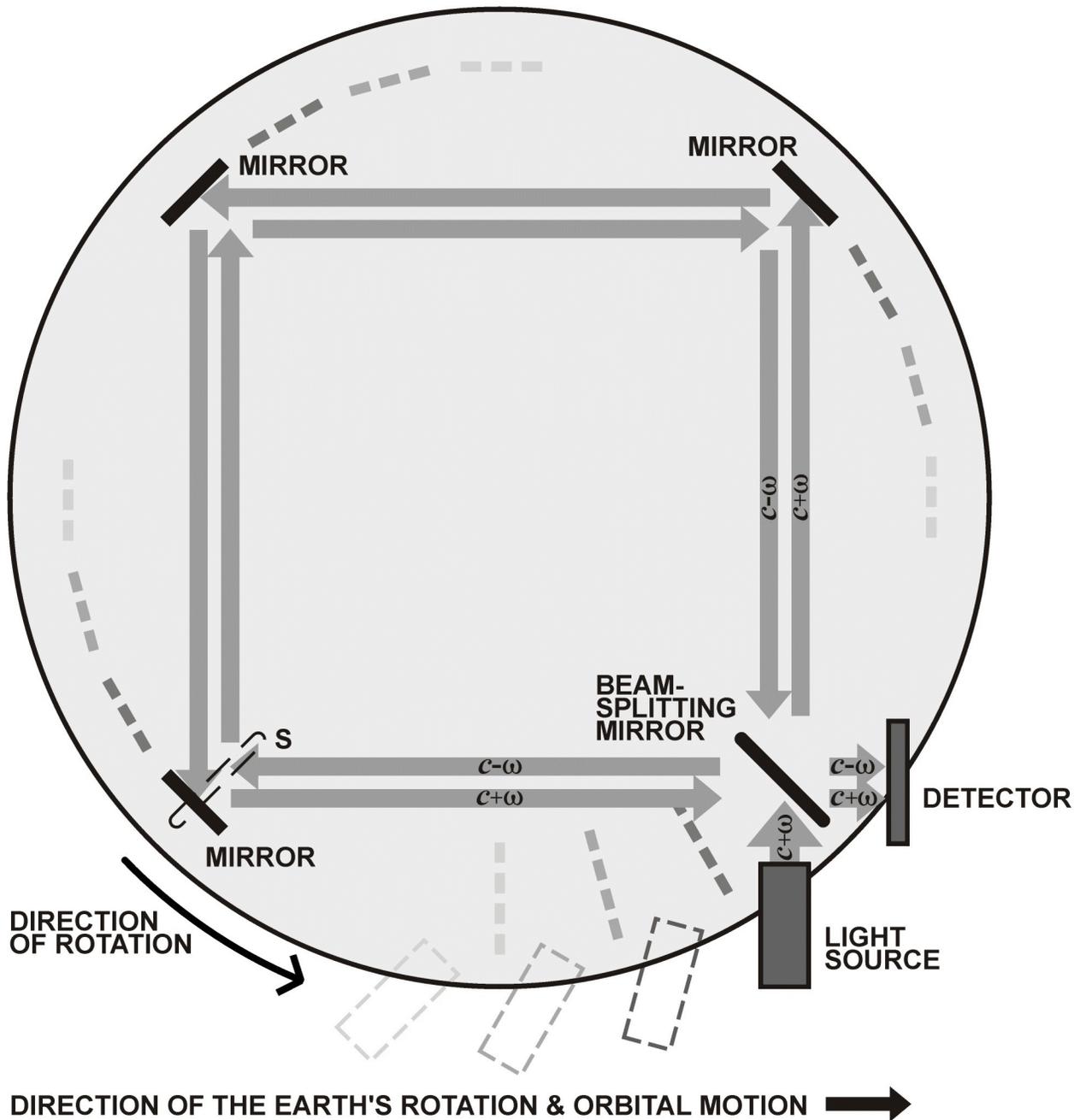
SAGNAC EFFECT - CONCEPTUAL DIAGRAM
WITH ROTATION - REALITY

The only consistent way to explain the effect is if light compounds with the motion of other reference frames. It always leaves its source at 186,000mi/s in all directions at the same time. The non-rotating condition and Michelson-Morley clearly confirm that.

The platform's angular velocity, ω, (or some vector angle of it, which for this diagram would be a 45°, or .707) has to be imparted to the light. Its emitter is moving with it. So it has to be added/subtracted to light's velocity: $c+\omega$ for the forward split light and $c-\omega$ for the rearward split light. The result is that both beams reach the detector at the same time. But it's their different velocities that puts them out of phase and produces the interference pattern, not their different arrival times.

Sagnac's experiment unequivocally establishes light's compounding with the relative motion of other reference frames.

Figure 4.4   (49.4 Sagnac Exp vi 5a)

24

Light's Variability

A couple of years after presuming light's constancy as the basis for relativity (1905), Einstein began to modify his position (1907). He decided that the speed of light is actually variable.[8] Its velocity and path change as it traverses a gravity field. Many have difficulty believing this. They're holding on to the popular narrative that he proved its constancy. And why not? Einstein believed it. He maintains that it's still fixed despite the contradiction [24].

(A gravity field can be defined as the region surrounding any amount of mass, including that of subatomic particles, that exerts an "attractive" influence on other mass [25]. Mass is the property of a body that's commonly taken as a measure of the amount of material or matter it contains and causes it to have weight in a gravitational field [26]. Matter is physical substance [27].)

For his explanation of starlight's displacement observed during the 1919 eclipse that supposedly confirmed general relativity, he correctly concludes that: "A curvature of rays of light can only take place when the velocity of propagation of light varies with position [in gravity fields]." He also explains that, "the general theory of relativity cannot retain this law, [the law of the constancy of the velocity of light]... the velocity of light must always depend on the co-ordinates when a gravitational field is present... the principle of the constancy of the velocity of light [is] valid only with respect to an inertial system [not a gravity field] [28]." All of this amounts to nothing more than light's refraction. (Refraction can be defined as light's displacement due to a change in its velocity due to a change in the density of the medium it's traversing [29].)

The problem is, just like with its compounding, its variability fundamentally invalidates relativity's founding premise. But he never reverses his position on its constancy. Just the opposite, he maintains that both are true despite the nullifying contradiction.

8. In his article, "The speed of light is not constant," on his website, The Physics Detective (https://physicsdetective.com/the-speed-of-light/) John Duffield has assembled eight more Einstein quotes from eight papers beginning from 1907 through 1920 from THE COLLECTED PAPERS OF ALBERT EINSTEIN from the Princeton University Press that affirm Einstein's evolved belief in and contradictory assertion of light's variability.

He tries to argue that special relativity is still valid despite light's variability because, "its results hold only so long as we are able to disregard the influences of gravitational fields... The special theory of relativity has reference to Galileian domains, *i.e.* to those in which no gravitational field exists [30]." How does that work?

Where are the locations where gravity fields don't exist or the conditions under which the effect of gravity fields can be ignored? Whether it's at the subatomic level or the self-gravity of our entire (presumed) finite universe, gravity fields are everywhere. They surround and permeate every object and they extend indefinitely. So there's no place where they aren't. So there's no way they can be disregarded.

Which means light's velocity has no possibility of ever being fixed (if it wasn't already conceptually impossible). It has to vary everywhere. And that's in addition to its compounding. Without its underlying premise, how can relativity, or any of its ancillaries like the Lorentz transformation or Einstein's application of relativity to the theorem of addition of velocities, have any validity? They all become nothing more than theoretical contrivances that have no practical relevance.

Einstein could not disagree. He qualifies his assertion of light's variability: "[Relativity's] results hold only so long as we are able to disregard the influences of gravitational fields on the phenomena (*e.g.* of light) [that causes its variability]." If we're unable to disregard gravity fields, as we just reasoned is impossible because they're everywhere so light's velocity has to vary everywhere, then, "as a consequence of this, the special theory of relativity and with it the whole theory of relativity would be laid in the dust [31]." Our entire cosmology, including the big bang, is rooted in a theory whose originator would have to concede is altogether untenable. (See **Figures 5.1**, Light's Bending; **5.2**, Light's Refraction)
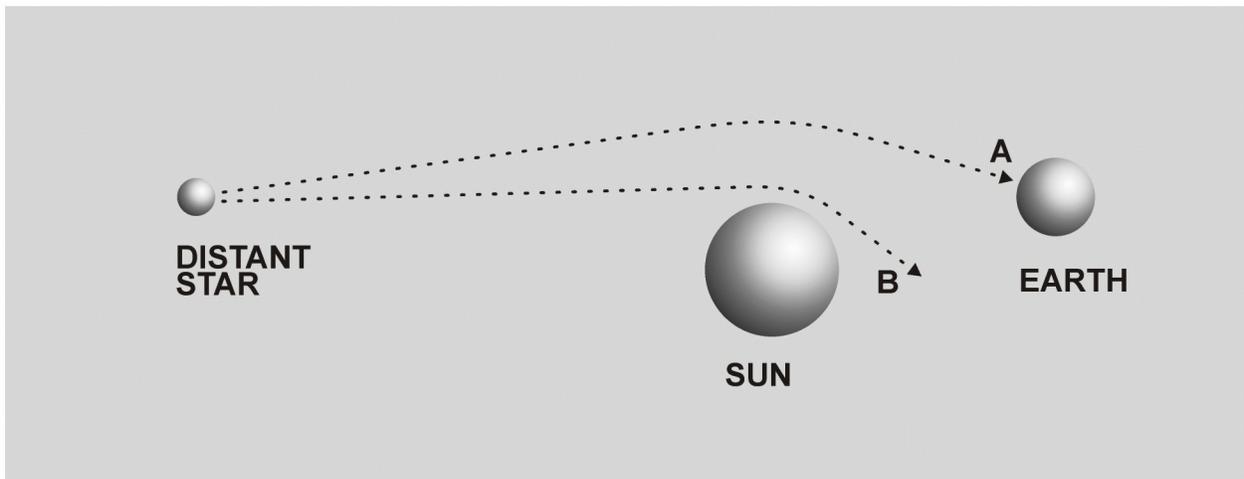
LIGHT'S BENDING

Our current belief is that a "ray" of light from a star or any distant object passing near a massive body like our sun is being pulled by gravity, that it's being bent from its otherwise straight path in the direction of **B** as it follows space's geodesic that somehow curves two-dimensionally in the vicinity of mass. And when viewed from Earth, its position is distorted in the direction of **A** due to an optical illusion.

Even though Einstein contends that light's distortion is actually due to its slowing through gravity fields, which is nothing more than refraction, which contradicts relativity's founding premise, light's fixed velocity, we reject his explanation. Instead, we hold to our belief that a photon, which remember is only a hypothetical quantum of massless energy, is subject to gravity's influence. We first mistakenly assumed that a photon is a particle. And then we incorrectly reason that because it's in motion it must have momentum. If it has momentum, it must have inertial mass. And then because of relativity's principle of equivalence, if it has inertial mass it must also have gravitational mass. And if it has gravitational mass, it must then be affected by gravity.

We're highly motivated to retain this convoluted logic because if we use light's refracted slowing like Einstein, we're abruptly confronted with the total collapse of relativity, which is wholly dependent on light's constancy. Incredibly, Einstein actually agrees that relativity would completely unravel if it were found that light's velocity was not fixed but variable.

Figure 5.1

(15.1.1 Refraction vi 5a)
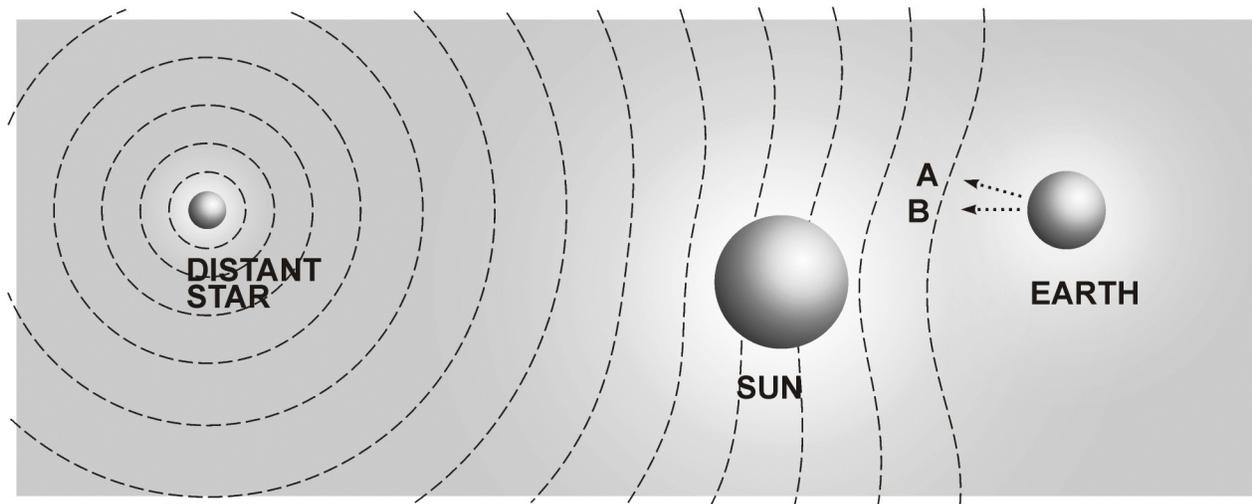
LIGHT'S REFRACTION

Light refracts through gravity fields. The distant star appears displaced in the direction of **A** not because light rays follow the impossible curvature of two-dimensional space or a resultant optical illusion but because the light in that direction reaches us slightly before the light coming directly straight from the star in the direction of **B**. Light's velocity slows through the decreasing density of the Sun's gravitational field, depicted in section as the diffusing background, just as any wave travels slower through a less dense medium, as portrayed by the series of circular and waving dashed lines that indicate the varying velocity of the incoming light emanating from the distant star.

It's also light's refracted slowing that's responsible for the gravitational lensing of distant galaxies or quasars that are split into two or more images that are assumed to be the product of the mass of some unseen foreground galaxy that's closer but fainter. But more often than not, it's just the common center of mass of any number of galaxies or galaxy clusters that is located between us and the object along its line of sight that's responsible for the lensing effect, which is why the refracting mass is so often never identified.

Figure 5.2   (15.1.2 Refraction vi 5a)

Experimental Confirmation

All those airborne clock experiments that are presumed to confirm light's constancy, where it's believed that they're forcing time's slowing with motion as compared to ground-based clocks have perfectly rational and natural explanations that don't include metaphysical relativistic phenomena [32]. The effect of the Earth's magnetic field on an atomic clock's cesium atoms is the source of the results. Their motion through it infuses them with a small charge that slightly increases their mass/size, which slows their natural frequency that in turn slows their clock's rate of operation, not time's rate.

Those other experiments that presumably demonstrate time's increasing rate with elevation are actually recording a slight increase in the cesium atoms' natural frequency due to their minor contraction in the ever-decreasing density of the Earth's magnetic field. This is what's actually increasing their clock's rate of operation with elevation. It's not time's increasing rate.

For much higher altitudes/distances, the Earth's very much stronger gravity field begins to govern. As a clock moves farther away, its cesium atoms begin to enlarge in the ever-increasing density of the Earth's gravity field. They also acquire a charge from their motion through it. So both cause a slight increase in their size and mass that decreases their natural frequency that in turn slows their clock's rate of operation, not its rate of time.

Light's variability also affects the readings of all these experiments. Its velocity propagates slower as field density decreases and faster as it increases. If fields and their density affect the natural frequency of subatomic particles/atoms then how can the cesium atoms of atomic clocks remain unaffected by their position and motion through them? They can't.[9] (See **Figure 6**, Field's Effect on Size; **Figure 7**, 1971 Hafele & Keating Airborne Clock Experiment)

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9. For more on field density see: "Gravitation's Origin and Impetus," viXra, May 12, 2023, http://vixra.org/abs/2305.0094.

1. MAGNETIC FIELD   **2. GRAVITY FIELD**   **3. BOTH FIELDS**
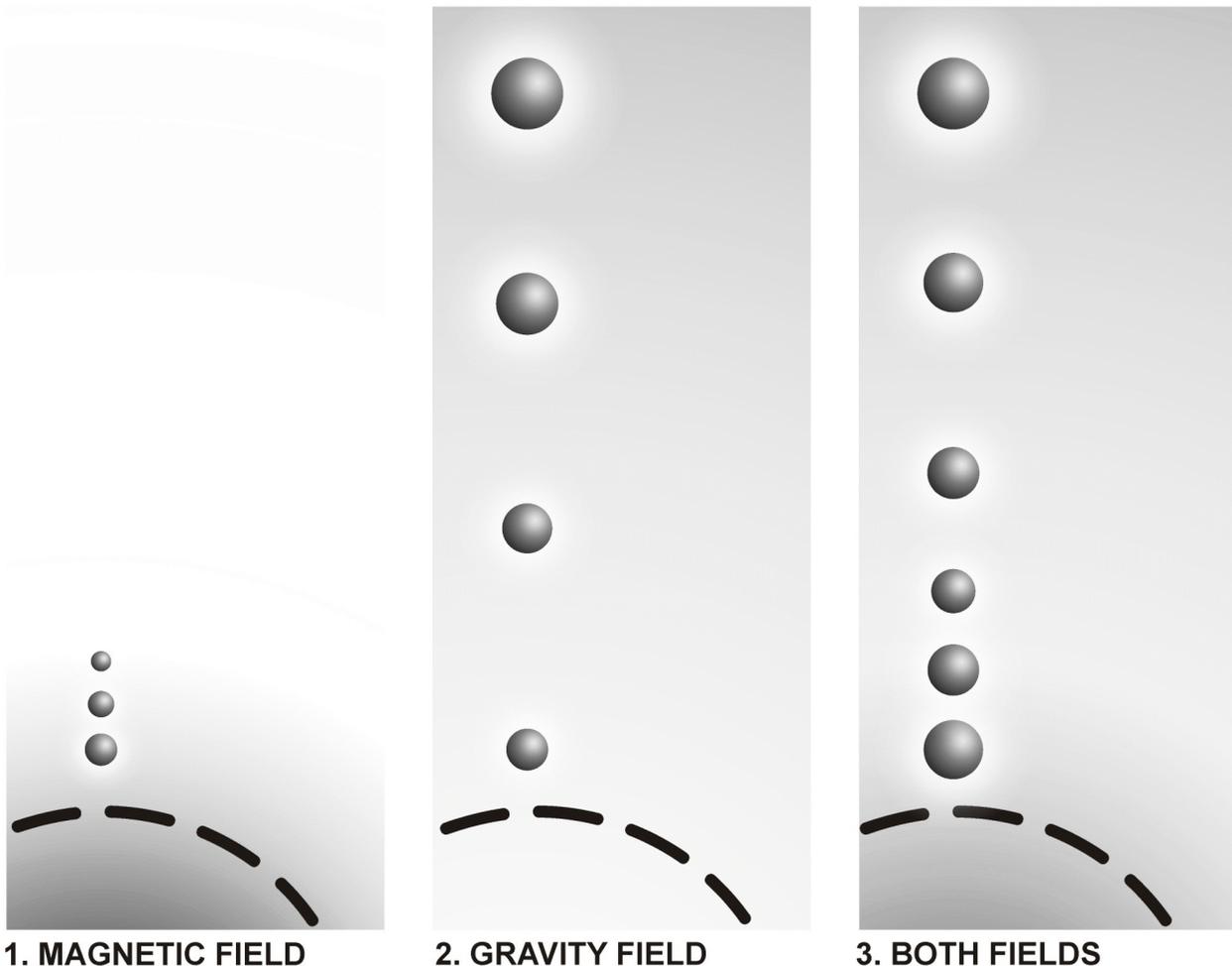
FIELD'S EFFECT ON SIZE

Subatomic particles are congealed out of the universal field of radiant energy. There are no particles per se, or the objects they compose. Ultimately, there are only condensed fields that are an inseparable extension of the infinitely continuous universal field from which they arose. So when its density decreases or increases like when it expresses as a magnetic or gravity field, the size of any nearby object in it has to vary correspondingly.

In diagram **1**, imagine the Earth, omitted for clarity but where its surface is represented by the curving dashed line, without a gravity field but left with only its magnetic field. Its density dissipates from its center out exponentially, as depicted in section by the diffusing background. So all objects, including the cesium atoms of an atomic clock, would have to decrease in size correspondingly with altitude, as indicated by the sequence of spheres, which in turn causes their natural frequency to increase, making the clock run faster.

In diagram **2**, now imagine the Earth without its magnetic field but left with only its gravity field. Its density increases with altitude exponentially. So any object, or again the cesium atoms of an atomic clock, would have to increase in size correspondingly as they move farther away, causing their natural frequency to decrease and the clock to run slower.

In **3,** the compounded effect of both fields is portrayed. Objects first contract then slowly begin to enlarge as they move farther away. The gradient in the magnetic field is greater over a shorter distance because of its much smaller size while the gradient is much smaller for the gravity field because of its much larger size, which yields little change over the same distance. The sizes and effects suggested have been greatly exaggerated for clarity.

Figure 6   (5 Density vi 10a)
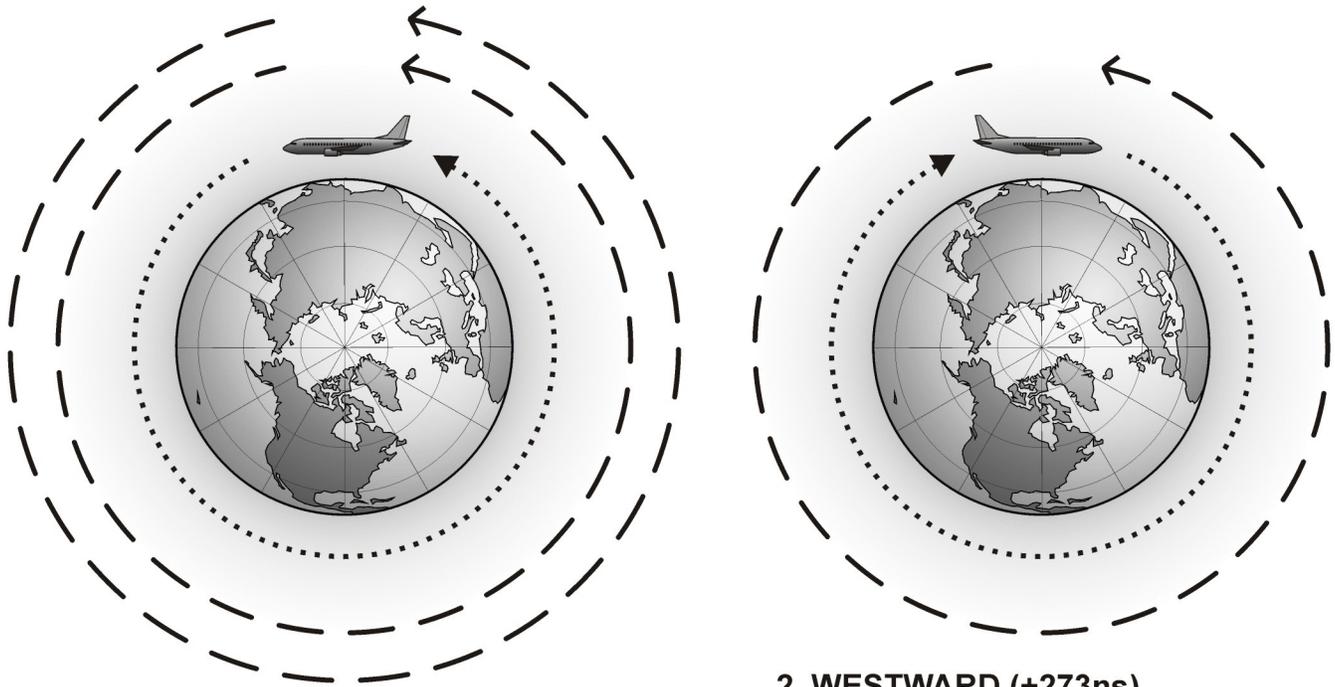
1. EASTWARD (-59ns)
THE CLOCKS' MOTION THROUGH OUR GRAVITATIONAL & MAGNETIC FIELDS DECREASED THEIR CESIUM ATOMS' NATURAL FREQUENCY MORE THAN THEIR ALTITUDE IN OUR MAGNETIC FIELD INCREASED IT

2. WESTWARD (+273ns)
THE CLOCKS' ALTITUDE IN OUR MAGNETIC FIELD INCREASED THEIR CESIUM ATOMS' NATURAL FREQUENCY MORE THAN THEIR MOTION THROUGH OUR GRAVITATIONAL & MAGNETIC FIELDS DECREASED IT

1971 HAFELE AND KEATING AIRBORNE CLOCK EXPERIMENT

There are practical commonsense explanations for the results of all those airborne clock experiments that don't rely on special relativity's self-conflicted, metaphysical effects, length's one-dimensional contraction that's bound to nonexistent time's three-dimensional dilation that impossibly enforces light's presumed constancy.

If we assume for convenience that the speed of the jet airliners carrying the clocks is roughly 500mph and about half the speed of the Earth's rotation, we can then see how when traveling in the eastward direction, with the Earth's rotation, the airliner would complete two revolutions in the time it takes to fly one. This would induce a charge to the clocks' cesium atoms from one revolution through the Earth's magnetic field and two revolutions through its gravitational field, which would increase the cesium atoms' size and mass that would slow their natural frequency, making their clocks run slower.

In the westward direction, the clocks' motion through our magnetic field would remain the same, one revolution. But because they're traveling in the opposite direction of the Earth's rotation, they're only traveling half the distance at half the speed through its gravitational field. So their cesium atoms' acquired charge would be much less than in the eastward direction, still slowing their clocks' rate, but not nearly as much.

When the effect is compounded with the increase in the cesium atoms' natural frequency due to the aircrafts' altitude in our magnetic field where the atoms contract because of the decrease in its density, coupled with only a very slight increase in density from our gravitational field, the eastward clocks end up with a greater mass and slower natural frequency that causes them to run slightly slower than the ground-based clocks.

Conversely, for the westward clocks, not having acquired nearly the same charge, the decrease in their cesium atoms' natural frequency is less than the increase resulting from their altitude. This leaves them with a higher natural frequency than the ground-based clocks that causes them to run faster. Any effect from our orbital motion through our Sun and galaxy's gravitational field can be excluded. It's essentially the same either way.

Figure 7

(6 Clocks vi 10a)

31

Conclusion

It's conceptually impossible for light's velocity to remain fixed. Simple logic and all of the most relevant experiments clearly demonstrate how it's mechanically required to compound with the motion of its source and the motion of other reference frames. And that's in addition to its irrefutable variability that undermines its constancy as well. Without light's constancy, relativity loses its founding premise and becomes conceptually unworkable.

Declarations

The author certifies that he did not receive any funding, grants, or any type of support from any individual, institution, or organization in the connection with the study or preparation of this work. The author further certifies that he does not have any financial or competing interests in connection with this work or ties of any kind to any individual or organization that might.

References

[1] Albert Einstein, *Relativity: The Special and the General Theory,* 15th ed. Translated by Robert W. Lawson (New York: Three Rivers Press, 1961), 21-23.

[2] Einstein, *Relativity,* 21.

[3] Einstein, *Relativity,* 41, 47, 53, 85, 104, 171.

[4] "Cartesian coordinate system," Wikipedia: The Free Encyclopedia, last modified Aug 30, 2023, https://en.wikipedia.org/wiki/Cartesian_coordinate_system.

[5] Einstein, *Relativity,* 67-68.

[6] Einstein, *Relativity,* 69.

[7] Einstein, *Relativity,* 40-44.

[8] Einstein, *Relativity,* 34-39.

[9] Einstein, *Relativity,* 44.

[10] Einstein, *Relativity,* 45-46.

[11] I first referenced this quote years ago but have since lost its source. It may be paraphrased, but I doubt it. In any case, it would not be conceptually inconsistent with other pronouncements. He expresses similar sentiment on page 85 and 151 of *Relativity*.

[12] "Ether," Merriam-Webster Dictionary, last access Dec 5, 2023, https://www.merriam-webster.com/dictionary/ether.

[13] Einstein, *Relativity*, 58-60, 167-168.

[14] "Michelson-Morley Experiment," Wikipedia, last modified Dec 26, 2022, https://en.wikipedia.org/wiki/Michelson-Morley_experiment.

[15] Einstein, *Relativity*, 31.

[16] "Sagnac Effect," Wikipedia, last modified Dec 24, 2022, https//en.wikipedia.org/wiki/Sagnac_effect.

[17] "Doppler effect," Britannica, last modified May 12, 2023, https://www.britannica.com/science/Doppler-effect.

[18] "Sagnac effect," Wikipedia, last modified Oct 23, 2022, https://en.wikipedia.org/wiki/Sagnac_effect, footnoted [18] A. Einstein, 'Generalized theory of relativity', 94; the anthology 'The Principle of Relativity', A. Einstein and H. Minkowski, University of Calcutta, 1920.

[19] Einstein, *Relativity,* 44.

[20] Einstein, *Relativity,* 90-91.

[21] Einstein, *Relativity*, 85, 104, 109, 171.

[22] Einstein, *Relativity*, 75-79, 172.

[23] Einstein, *Relativity*, 29-31.

[24] Einstein, *Relativity*, 85-87.

[25] "Gravitational field," Wikipedia, last modified Apr 6, 2023, https://en.wikipedia.org/wiki/Gravitational_field.

[26] "Mass," Merriam-Webster Dictionary, last access Aug 30, 2023, https://www.merriam-webster.com/dictionary/mass.

[27] "Matter," Cambridge Dictionary, last access Aug 30, 2023, https://dictionary.cambridge.org/us/dictionary/english/matter.

[28] Einstein, *Relativity*, 85, 104, 171.

[29] "Refraction," Wikipedia, last modified Feb 5, 2023, https://en.wikipedia.org/wiki/Refraction.

[30] Einstein, *Relativity*, 85, 109.

[31] Einstein, *Relativity*, 85.

[32] "Hafele–Keating experiment," Wikipedia, last modified Sep 2, 2023, https://en.wikipedia.org/wiki/Hafele-Keating_experiment.

Bibliography

Arp, Halton. *Seeing Red: Redshifts, Cosmology & Academic Science*. Montreal: Aperiron, 1998.

Einstein, Albert. *The Meaning of Relativity*. 5th ed. Translated by Edwin Plimpton Adams, Ernst G. Straus, Sonja Bargmann. Princeton: Princeton University Press, 1953.

Einstein, Albert. *Relativity: The Special and the General Theory*. 15th ed. Translated by Robert W. Lawson. NY: Three Rivers Press, 1961.

Encyclopedia Britannica, last access 2024, https://www.britannica.com.

Gonder, Kenneth. *The Reality of Relativity*. 7.4 240120, Last revision 2024. Amazon or B&N, Independently published, 2018, https://www.amazon.com/dp/B07CVMDV66 or https://www.barnesandnoble.com/w/the-reality-of-relativity-kenneth-gonder/1137950355?ean=2940162675266, (LCCN: 2020901711).

Hyperphysics, last access 2024, http://hyperphysics.phy-astr.gsu.edu.

Merriam-Webster Dictionary, last access 2024, https://www.merriam-webster.com.

NASA, last access 2024, https://www.nasa.gov.

Science News, 1999 - 2018. https://www.sciencenews.org.

Scientific American, 1994 - 2024, https://www.scientificamerican.com.

Sky & Telescope, 2000 - 2024, https://skyandtelescope.org.

Wikipedia: The Free Encyclopedia, last access 2024, https://www.wikipedia.org.