An Analysis of Einstein's Second Postulate to his Theory of Special Relativity

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Abstract

An analysis of books, presentations and scientific papers about Albert Einstein's Second Postulate to his Theory of Special Relativity shows that there is a fundamental disagreement between what Einstein wrote and how what he wrote is being interpreted by mathematician-physicists and taught in colleges and universities around the world. An analysis of the evidence shows that Einstein was correct and the vast majority of interpretations and teachings are incorrect.

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I. INTRODUCTION

In early 1912, seven years after his Special Theory of Relativity was published, Einstein famously lamented, "Since the mathematicians have invaded the theory of relativity I do not understand it myself anymore."[1] Nine years later, in a talk he gave to the Prussian Academy of Sciences, he stated, "As far as the laws of mathematics refer to reality, they are not certain, and as far as they are certain, they do not refer to reality."[2] In one of his letters, he referred to the interpretations by mathematicians as a ***disease*** when he wrote to his friend Paul Ehrenfest, "You are one of the few theoreticians who has not been robbed of his common sense by the mathematical **contagion**."[3] Einstein went to his grave arguing with mathematicians and advocates of Quantum Mechanics over how to interpret his theories of Relativity.

Today, over a hundred years later, it seems the mathematicians won. It is difficult to find any book or paper that correctly cites and correctly interprets Einstein's First and Second Postulates to his Special Theory of Relativity – particularly the Second Postulate. Colleges and Universities appear to teach only the mathematicians' interpretation.

II. "EINSTEIN'S EMITTER ONLY THEORY"

Einstein's 1905 paper *On the Electrodynamics of Moving Bodies* [4] begins with a description of certain "asymmetries" regarding how magnets and conductors appear to work when one is moving while the other is "at rest." Then, while still on page 1, Einstein introduced his First and Second postulates:

> "Examples of this sort, together with the unsuccessful attempts to discover any motion of the earth relatively to the "light medium," suggest that the phenomena of electrodynamics as well as of mechanics possess no properties corresponding to the idea of absolute rest. They suggest rather that, as has already been shown to the first order of small quantities, **the same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good**. We will raise this conjecture (the purport of which will hereafter be called the "Principle of Relativity") to the status of a postulate, and also introduce another postulate, which is only apparently irreconcilable with the former, namely, that **light is always propagated in empty space with a definite velocity *c* which is independent of the state of motion of the emitting body**. These two postulates suffice for the attainment of a simple and consistent theory of the electrodynamics of moving bodies based on Maxwell's theory for stationary bodies."

The first postulate is, therefore, "the same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good." And the Second Postulate is, "light is always propagated in empty space with a definite velocity *c* which is independent of the state of motion of the **emitting** body." Note that Einstein said nothing about what any other observer might see or measure.

In this paper, I will refer to Einstein's version of his Second Postulate as "Einstein's Emitter Only Theory," and I will compare it to the "Mathematicians' All Observers Theory" that is being taught in colleges and universities around the world. Then I will examine the experiments and the evidence, which fully support Einstein's theory and fully disprove the mathematicians' theory.

III. THE “MATHEMATICIANS’ ALL OBSERVERS THEORY”

The earliest interpretation of the Second Postulate I could find is by American mathematical physicist Richard C. Tolman in a scientific paper he published in 1910:

> The second postulate of relativity is obtained by a combination of the first postulate with a principle which has long been familiar in the theory of light. This principle states that the velocity of light is unaffected by a motion of the emitting source, in other words, that the velocity with which light travels past any observer is not increased by a motion of the source of light towards the observer. The first postulate of relativity adds the idea that a motion of the source of light towards the observer is identical with a motion of the observer towards the source. **The second postulate of relativity is seen to be merely the combination of these two principles, since it states that the velocity of light in free space appears the same to all observers regardless both of the motion of the source of light and of the observer.[5]**

And here is an interpretation of the Second Postulate as printed in 2012 in the ninth edition of a widely used college text book:

> In 1905 Albert Einstein proposed a theory that explained the result of the Michelson–Morley experiment and completely altered our notions of space and time. He based his special theory of relativity on two postulates:
>
> 1. The principle of relativity: All the laws of physics are the same in all inertial frames.

2. The constancy of the speed of light: The speed of light in a vacuum has the same value, c = 2.997 924 58 x 108 m/s, in all inertial reference frames, **regardless of the velocity of the observer or the velocity of the source emitting the light**.[6]

A little research will find other college text books with minor variations on that same "all observer" wording. Examples:

"Second postulate: The speed of light is a constant and will be the same for **all observers independent of their motion relative to the light source**."[7]

"The unusual properties of the velocity of light are: **It is a constant for all observers, irrespective of how they are moving**. It is a universal speed limit, which no material object can exceed. **It is independent of the velocity of its source and that of the observer.**"[8]

"Einstein concluded by 1905 that Maxwell's theory must be reinterpreted: the speed of light will be exactly the same – a universal constant – for all observers, no matter whether they move (with constant velocity) relative to the source of the light. This highly original insight became Einstein's second postulate of relativity, the Principle of the Consistency of the Speed of Light:

"Light and all other forms of electromagnetic radiation are propagated in empty space with **a constant velocity c which is independent of the motion of the observer or the emitting body**.

"Einstein is saying that, whether moving at uniform speed toward or away from the source of light or alongside the emitted light beam, **any observer** always measures the exact same value for the speed of light in a vacuum, which is about 3.0 x 108 m/s or 300,000 km/s (186,000 mi/s)."[9]

There are a great many scientific papers and many other books which describe the second postulate in a similar way.

I will call this interpretation the "Mathematicians' All Observers Theory."

IV. COMPARING THE THEORIES

Einstein's theory is simple and straightforward. There is a physical limit to how fast light can travel, and therefore light cannot physically exceed that limit. Light is **emitted** at its maximum speed of 299,792,458 meters **per local second**, (mathematically referred to as c) regardless of whether the emitting source is moving or not. The emitting body's velocity (referred to as v) cannot be added to the speed of light being emitted, since $c + v$ would produce a speed greater than the maximum that light can physically travel. Einstein says nothing about what others may observe or measure for the speed of light, since their movements do not actually physically affect the speed of the light, only how they measure it. Thus, an observer approaching the source of light will measure the light to arrive at $c + v$, where v is his velocity, and if the observer is moving away from the source of the light, he will measure the light to arrive at $c - v$. That is totally in tune with common sense. How could an observer affect the speed of light he didn't create? That would make no sense.

When Einstein wrote that the Second Postulate "is only apparently irreconcilable with" the First Postulate, he seems to have been referring to the fact that while the observer measures light **he emits** as moving at a speed that is independent of his own speed, that fact does **not** necessarily apply to light he may measure coming from another source outside of his frame of reference. Light coming from another source **can** arrive at *c* + or – *v*, where *v* is his own velocity. Some may interpret that to mean that different laws of electrodynamics and optics apply to the light from the other source. According to Einstein, such an interpretation would be incorrect. Light that is emitted by a moving emitter will travel at the speed of light as it exists **at the source of the light**, and light coming from another source (in the same "frame of reference" or in another "frame of reference") will travel at the speed of light as it exists **at its source**. The same "equations of mechanics hold good" for both emitters of light.

It appears that most mathematicians, however, could not accept that. Some books and papers explain why. One such book, "Fundamentals of Modern Physics" by Dr. Peter J. Nolan,[10] explains the problem this way (with my comments in **bold** and in brackets):

> Postulate 2 says that the velocity of light is always the same independent of the velocity of the source or of the observer. **[As we have seen, it says <u>nothing</u> about any observer.]** This can be taken as an experimental fact deduced from the Michelson-Morley experiment. **[The Michelson-Morley experiment[11] also says <u>nothing</u> about outside observers.]** However, Einstein, when asked years later if he had been aware of the results of the Michelson-Morley experiment, replied that he was not sure if he had been. Einstein came on the second postulate from a different viewpoint. According to his first postulate, the laws of physics must be the same for all inertial observers. If the velocity of light is different for different observers, then the observer could tell whether he was at rest or in motion at some constant velocity, simply by determining the velocity of light in his frame of reference. **[Einstein's Theory of Relativity says that each observer will measure the speed of light to be *c* in his local frame of reference.]** If the

observed velocity of light c' were equal to c then the observer would be in the frame of reference that is at rest. If the observed velocity of light were c' = c - v, then the observer was in a frame of reference that was receding from the rest frame. Finally, if the observed velocity c' = c - v, then the observer would be in a frame of reference that was approaching the rest frame. Obviously these various values of c' would be a violation of the first postulate, since we could now define an absolute rest frame (c' = c), which would be different than all the other inertial frames. **[Einstein specifically stated that "the phenomena of electrodynamics as well as of mechanics possess no properties corresponding to the idea of absolute rest," and since he was only concerned with the speed of the emitter, other frames of reference are of no concern.]**

Summing up: According to the "Mathematicians' All Observers Theory," the speed of light is the same for **all observers**. If you have ten different space ships all approaching a light source at different speeds, they will all measure the light from that source as arriving at the same speed the light **source** measures it, i.e., 299,792,458 meters second. According to "Einstein's Emitter Only Theory," only the source (the emitter) will measure the speed of light traveling at *c*, and the ten space ships will all measure light arriving at a different *c* + *v*, where *v* is each individual ship's velocity.

The two interpretations couldn't be more different. Fortunately, scientists know how to resolve such differences.

Physicist Richard Feynman once said that it does not make any difference how beautiful your theory is, it does not make any difference how smart you are, who developed the theory, or what his name is, "**If it disagrees with experiment, it is wrong.** In that simple statement is the key to science."[12]

So, we simply need to look at **experiments** which can confirm or disprove the different interpretations of Einstein's Second Postulate. But, before we can do that we need to understand how such experiments work to see what is actually happening with the light being measured.

V. HOW STANDARD SPEED OF LIGHT MEASUREMENTS ARE DONE

Mirrors are an essential part of most experiments to measure the speed of light, so it is very important to understand how mirrors work.

> "What actually happens on a microscopic level is that the incoming photon is absorbed by the electrons of the mirror, which are set into oscillation by the photon's oscillating electric field. The result is, for some materials (shiny ones), that the electrons' oscillation creates a **new photon** that moves away from the mirror in the opposite direction. The incoming and outgoing photons are free and move at speed c, but **they are not the same photon**…"**[13]**

In other words, when a mirror "reflects" light from some source, it doesn't just "bounce back" light as common terminology would suggest, the atoms in the mirror actually **absorb** the light photons and instantly **emit <u>new</u> photons**. The mirror becomes a **<u>new</u> emitter**.

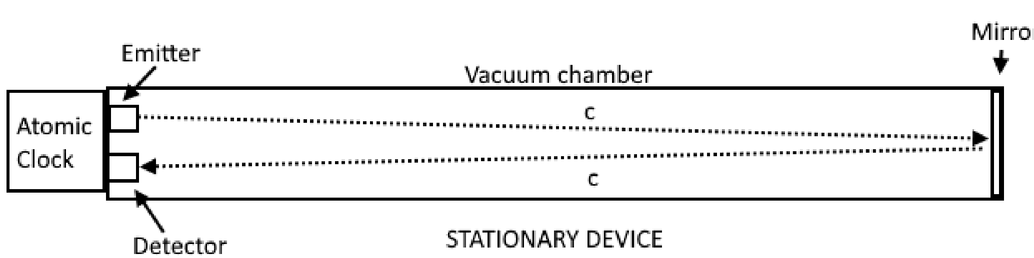

Figure 1

Figure 1 above illustrates the basics of current typical equipment for measuring the speed of light. At one end of a vacuum chamber of a specific length – say 2 meters - we have an atomic clock and a microchip that does the calculating and measuring. While it would be best to have atomic clocks at both ends so that the one-way speed of light could be measured, that would involve some procedure to verify that the two clocks are in ***perfect*** synchronization. Such a verification is ***extremely*** difficult (if not impossible) to achieve. Therefore, the device uses a single atomic clock next to the light source and a detector, and there is a mirror at the opposite end of the vacuum chamber.

The light source **emits** a pulse of photons at *c* toward the mirror, and the atomic clock records the time of emission. At that instant, the mirror is a stationary "observer" awaiting the arrival of the photons. The atoms in the mirror absorb the photons and **emit** new photons at *c* back to the detector. At that instant, the detector has become a stationary "observer" awaiting the arrival of the new photons. When the photons arrive at the detector, the atomic clock and microchip record the time of arrival. The microchip then computes the time between emission and receipt and computes the speed the photons must have been traveling to cover the distance within the device. The speed of light *c* in this experiment using relatively **stationary** equipment should be measured to be 299,792,458 meters per local second.

But what if the equipment is moving?

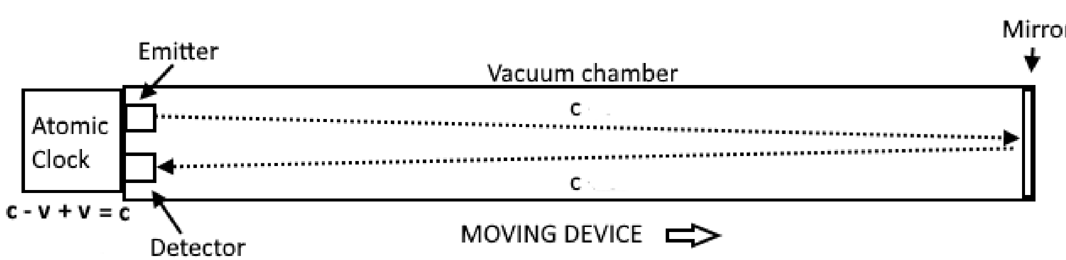

Figure 2

In Figure 2 above, the **entire device** is moving at a steady high speed rate from left to right. As in the stationary test, the light source **emits** a pulse of photons at *c* toward the mirror, and the atomic clock records the time of emission. At that instant, the mirror is a ***moving*** "observer" traveling away from the source of light at *v* as it awaits the arrival of the photons. The atoms in the mirror absorb the photons which arrive at *c* - *v* and **emit** new photons at *c* back to the detector. At that instant, the detector has become a moving "observer" traveling at *v* as it awaits the arrival of the new photons. When the photons arrive at the detector at *c* + *v*, the atomic clock records the time of arrival. The microchip then computes the time between emission and receipt and computes the speed the photons must have been traveling to cover the distance within the device. Although the light arrived at *c* – *v* when it reached the mirror and arrived at *c* + *v* when it reached the detector, because all parts of the device were moving together at the same constant speed, regardless of how the device is oriented, the movement of the device is cancelled out and the speed of light in this experiment using **moving** equipment should be measured to be 299,792,458 meters local second just as it was measured using stationary equipment.

VI. MEASURING LIGHT SPEEDS VIA WAVE LENGTHS

For over a hundred years scientists have known how to use prisms and spectrographs to measure the differences in the wavelengths of light. While such devices cannot measure the exact speed of light, a spectrograph can be used to measure differences in light wavelengths between two emitting sources.

Therefore, if you take the light speed measuring device pictured in Figure 2, remove the atomic clock, replace the mirror with a half-silvered mirror that will allow half the emitted light to pass through, and put spectrographs at both ends, you will get a device as shown in Figure 3.

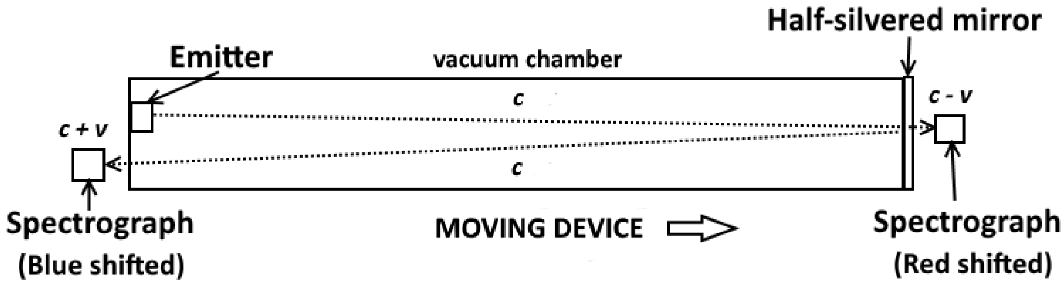

Figure 3

When the device is moving from left to right at high speed, the light emitted from the emitter will travel at *c* to the half-silvered mirror where half of the light will be reflected back and the other half will enter the spectrograph behind the mirror. That spectrograph on the right will measure the light's **wavelength** as being ***longer***, since it arrived at *c – v*, where *v* is the speed of the spectrograph as it moves **away** from **point** where the light was emitted. The reflected light will travel at c back to the spectrograph next to the emitter. That spectrograph will measure the light's **wavelength** as being ***shorter,*** since it arrived at c + v, where v is the speed of that spectrometer as it moved **toward** the point where the reflected light was emitted.

It is also interesting to note that if the device were positioned to be perpendicular to the direction of movement, there would be no red or blue shifting, since the two spectrographs would be moving parallel to each other, instead of one following the other.

VII. COMPARING LIGHT WAVELENGTHS

While the device shown in Figure 3 will demonstrate that light wavelengths will appear longer when you are moving away from the light source, and light wavelengths will appear shorter when moving toward the light source, the device has no actual capability to allow anyone to actually **measure** that difference in the observed wavelengths. To measure the differences in wavelength between two sources, you can use a Michelson interferometer, a device invented by Albert A. Michelson around 1887 for the purpose of measuring and comparing wavelengths.

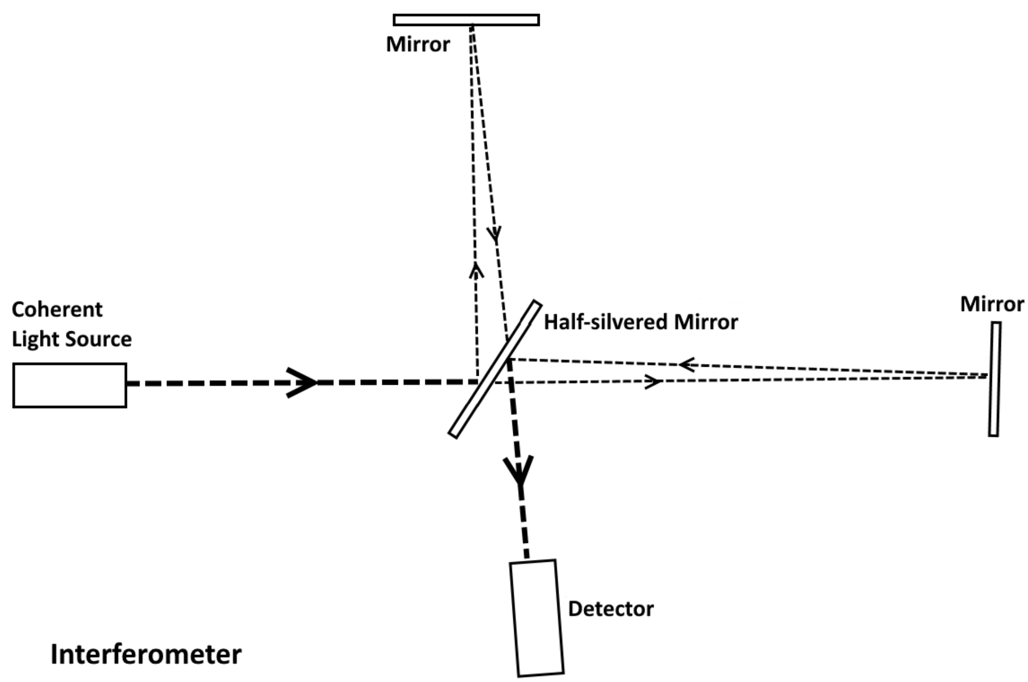

Figure 4

An interferometer allows the comparison of the wavelengths of two different coherent light sources. In Figure 4, the light begins as a single source of coherent light, which means the light has only one wavelength and one speed. The light beam is directed toward a half-silvered mirror (also known as a "beam-splitter") which reflects (re-emits) half of the light at an angle toward the mirror at the top of Figure 4. The other half of the light passes through to the mirror on the right. The light that passed through the mirror is reflected back (re-emitted) at a slightly different angle by the mirror on the right toward the reverse side of the half-silvered mirror. The light is then reflected (re-emitted) toward the detector at the bottom of Figure 4. Meanwhile, the light that was reflected toward the mirror at the top of Figure 4 is reflected (re-emitted) back at a slightly different angle toward the half-silvered mirror. It passes through the mirror and merges with the light from the other direction to enter the detector as two combined beams.

The detector receives the two different beams, and it allows a comparison of the wavelengths. By careful adjustment of the mirrors, if the two beams are still of the same wavelength, they will merge into coherent light once again and the interferometer will show them as a solid beam of light.

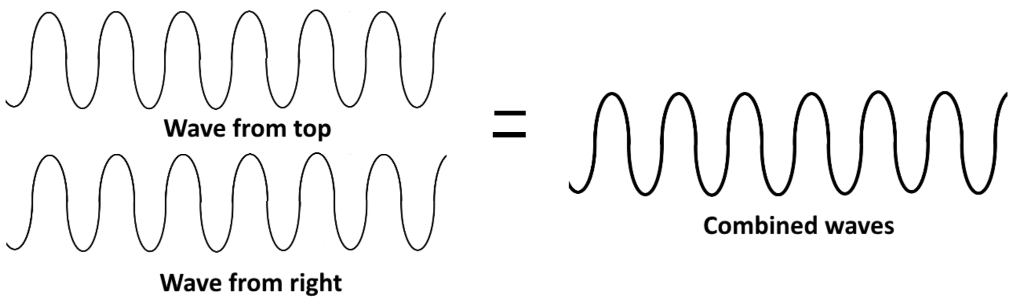

Figure 5

A simple adjustment of a mirror, however, can put the two waves in direct conflict, where the troughs of one wave series will exactly match the crests of the second wave series and the interferometer will show no visible light.

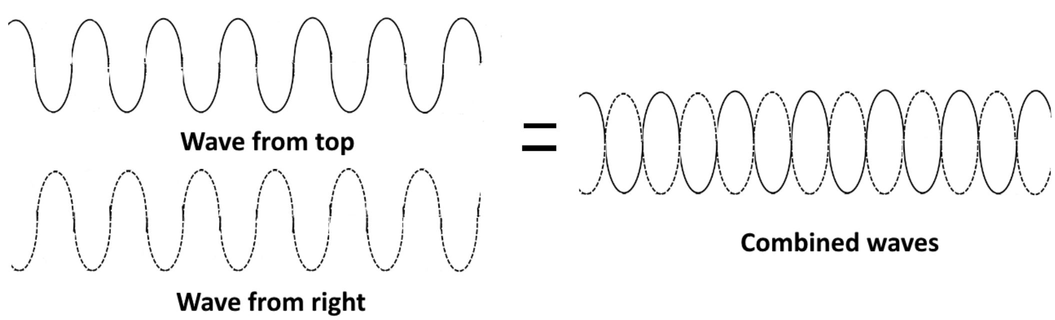

Figure 6

If, however, one beam has a different wavelength than the other, the waves will interfere with each other as shown in Figure 7.

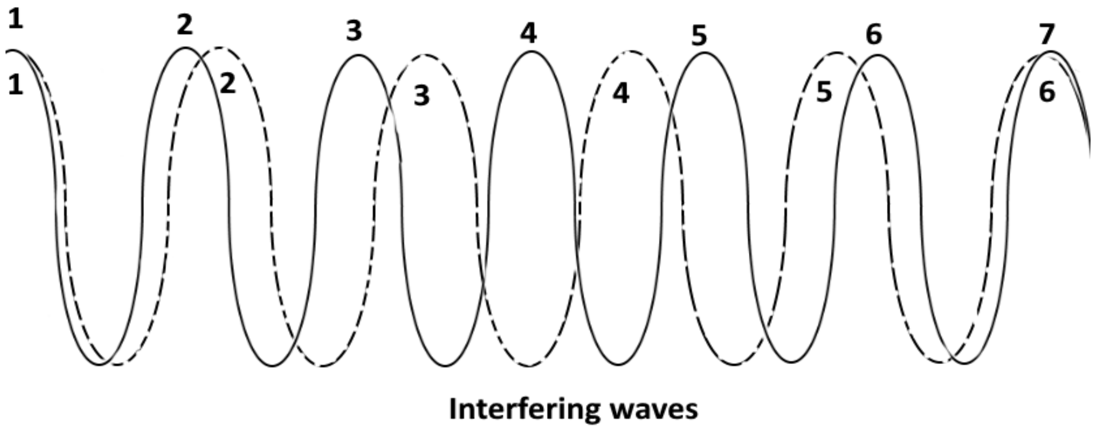

Figure 7

In the wave pattern shown in Figure 7, wave 1 of both beams coincide, 2 and 3 are partially conflicting, and wave 4 is in full conflict. And the pattern will repeat with periodic matching of wave crests and periodic full conflict between crests and toughs.

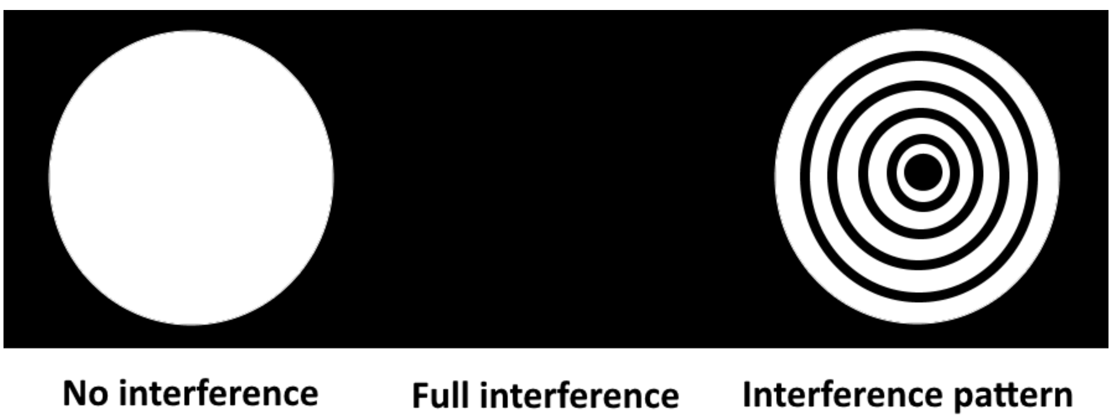

Figure 8

When the detector is equipped with a lens that allows projection of the light on a screen, if the light waves are aligned as in Figure 5, a solid spot of color will be projected. If the waves are of the same length but just "out of phase," with the troughs of each wave in one beam exactly matching the crests of the each wave in the second beam as in Figure 6, full interference will project no visible light. And, if the waves are not of the same length, as in Figure 7, an interference pattern will be displayed, a pattern of alternating light and dark areas where waves coincide and where they conflict as shown in Figure 8.

The interferometer is one of the devices that has been used to perform tests which show which definition of Einstein's Second Postulate is correct.

VIII. PUBLISHED EXPERIMENTS TESTING THE SECOND POSTULATE

One of the first experiments to attempt to measure difference in wave lengths under different situations was performed by Albert A. Michelson and Edward W. Morley in 1887,[11] eighteen years before Einstein first wrote about his "Second Postulate."

Since it was observed that ocean waves travel through water and sound waves travel through the air, it was assumed by Michelson and Morley that light waves must also travel through some sort of medium. Their experiment was performed to test for that medium. The imagined medium was assumed to a stationary "luminiferous aether" that filled the entire universe. Their reasoning was that, just as a moving vehicle produces "air resistance" felt as a "wind" that seems to rush past the vehicle, the Earth moving through this stationary "luminiferous aether" must also produce a "wind" that would seem to rush past the earth. Therefore, light sent in the direction the Earth would be moving would travel ***against*** the aether "wind" and should travel at a different rate than light sent at a right angle to the "wind" as the aether moves past the Earth.

The interferometer Michelson and Morley used is the device depicted in Figure 4, with a half-silvered mirror splitting a light beam into two beams, one traveling straight and the other traveling at a 90 degree angle away from the first. The completed experiments showed that the light waves appeared to arrive at the detector from both directions at the same wavelength, indicating that the earth was **not** moving through any kind of "luminiferous aether" medium which carries light waves.

As we saw in the quote from Dr. Nolan's book, mathematicians sometimes cite the Michelson-Morley experiment as confirming the "Mathematicians' All Observers Theory." That experiment measured the speed of light **emitted** in two different directions inside their laboratory, the second direction being 90 degrees different from the first. The experiment showed the speed of light in both directions to be the same, which agrees with "Einstein's Emitter Only Theory" but really has no meaning to the "Mathematicians' All Observers Theory." As with the standard method for measuring the speed of light, there were no moving emitters or moving observers involved. Moreover, the size of the equipment used by Michelson and Morley would not allow the measurement of very very small changes in wavelength where there are thousands of slightly interfering waves between matching crests and a full interference of crest against trough.

Searching further for experiments which mathematicians cite as confirming the "Mathematicians' All Observers Theory," I found that mathematicians frequently cite the pion experiment by Alväger et al. in 1964[14] as confirming their theory. Alväger et al. measured the speed of gamma rays emitted by a beam of pions moving at almost the speed of light with respect to their laboratory. They found that the speed of the light emitted by the moving sources was the same as light emitted by sources "at rest" in the laboratory. In other words, there was no moving observer involved. They confirmed "Einstein's Emitter Only Theory" but proved nothing about the "Mathematicians' All Observers Theory."

Mathematicians also cite an experiment performed in 2011 by E. B. Aleksandrov et al.[15] They did basically the same thing as Alväger; they measured "the velocity of the light pulse emitted by an ultrarelativistic electron bunch." They determined that the speed of light was not affected by the speed of the "ultrarelativistic electron bunch," further confirming "Einstein's Emitter Only Theory." Again, there was no moving observer involved.

Searching for published papers which **disprove** the "Mathematician's All Observers Theory," I found several.

In 1911, French scientist Georges Sagnac performed an experiment involving a moving emitter and moving mirrors. The results have become known as the "Sagnac Effect."[16] The experiment involved a light source emitting photons toward a half-silvered mirror which split the beam, sending photons clockwise and counterclockwise away from the emitter and toward a series of three mirrors which redirected the photons around a square and then to the detector (the "moving observer") as the entire measuring apparatus rotated on a large disk.

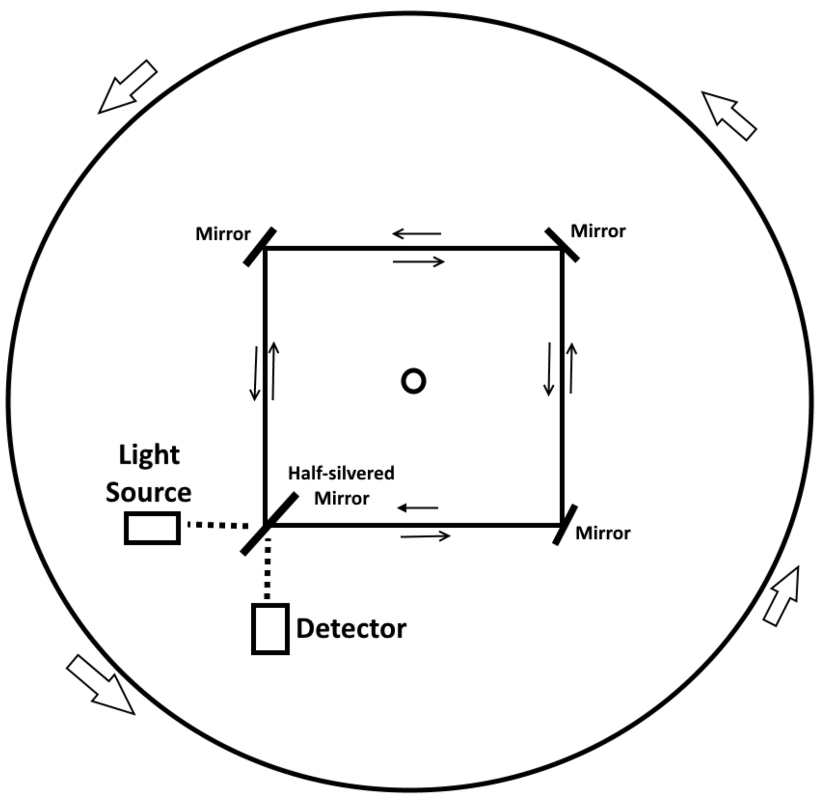

Figure 9

The experiment can be envisioned as being similar to a person on a rotating carrousel tossing balls (in a vacuum, of course) to a person ahead and to a person behind as the carrousel rotates. It is different in that, while a tossed ball **will** travel at the speed of the carrousel plus the throwing speed, light cannot exceed the "throwing speed" (or emitted speed) and thus will **not** combine with the speed of the carrousel. However, the catcher's (observer's or detector's) speed **will** mathematically combine.

The results of the Sagnac experiment showed that the light that moved with the rotation was measured to be traveling at $c - v$, where v was the speed of the rotating disc and the "moving observer" detector, and $c + v$ in the reverse direction, where light traveled against the rotation. The experiment fully confirmed "Einstein's Emitter Only Theory" and disproved the "Mathematicians' All Observers Theory."

In 1925, a different yet significantly similar experiment known as "The Michelson-Gale Experiment"[17] was performed by A. A. Michelson and Henry G. Gale on a tract of land near the current location of Midway Airport in Chicago, Illinois. It was different in that the equipment included a vacuum chamber that consisted of "a twelve-inch pipe laid on the surface of the ground in the form of a rectangle 2010 x 1113 feet," a vastly greater travel distance than used in lab equipment. It was also different from the Sagnac experiment in that the equipment didn't rotate in a circle but only moved sideways as the Earth turned on its axis. However, it was similar to the Sagnac experiment in that the light beam was split and sent around the rectangle in both directions, being re-emitted by mirrors along the way.

The results of the experiment showed that light traveled at $c + v$ when moving east to west against the rotation of the Earth, the light traveled at $c - v$ when moving west to east with the rotation of the Earth, and light traveled at c when moving north to south where the Earth's rotation had no effect. So, again "Einstein's Emitter Only Theory" is confirmed, and the "Mathematicians' All Observers Theory" is disproved.

IX. AN UNPUBLISHED EXPERIMENT TESTING THE SECOND POSTULATE

A search to find **unpublished** scientific papers which **disprove** the "Mathematicians' all observers" version of the Second Postulate found one very interesting paper.

Calculations performed by a NASA scientist in 2009 were consistent with the velocity of the observer **adding to** the oncoming speed of light when the observer is traveling toward the source of the light. I.e., the calculations were was fully consistent with "Einstein's Emitter Only Theory" and in direct conflict with the "Mathematicians' All Observer Theory." But, ***the scientist did not accept what he had calculated***.

The paper is titled "*Lunar Laser Ranging Test of the Invariance of c*."[18] It was written by a NASA scientist, Daniel Y. Gezari, who made the paper public via Cornell University and their arXiv.org library web site. The abstract reads as follows:

> The speed of laser light pulses launched from Earth and returned by a retro-reflector on the Moon was calculated from precision round-trip time-of-flight measurements and modeled distances. **The measured speed of light (c) in the moving observer's rest frame was found to exceed the canonical value c = 299,792,458 m/s by 200±10 m/s, just the speed of the observatory along the line-of-sight due to the rotation of the Earth during the measurements.** This result is a first-order violation of local Lorentz invariance; the speed of light seems to depend on the motion of the observer after all, as in classical wave theory, which implies that a preferred reference

frame exists for the propagation of light. However, the present experiment cannot identify the physical system to which such a preferred frame might be tied.

The experimental data was collected at the Apache Point Observatory (APO) which is located in Sunspot, New Mexico. APO is operated by the University of New Mexico, but is owned by a consortium of universities. According to Gezari's paper, experimental data collected by the University of California, San Diego (UCSD) during a UCSD project called APOLLO (Apache Point Lunar Laser-ranging Operation) was supplied to NASA scientist Gezari by the head of the APOLLO project, and Gezari used the data to make his calculations. After examining the data and his calculations, Gezari observed that the results showed that light could either travel faster than the speed of light **or** the movement of the earth during the round trip had to be added to the speed of light in direct violation of the "Mathematicians' All Observers" interpretation of Einstein's Second Postulate.

The APOLLO experiment was basically very simple (although in practice it is incredibly complex) and very similar to the Michelson-Gale Experiment, merely involving much greater distances. A reflector left on the moon by the Apollo 15 mission was designed to bounce any light emitted directly toward it directly back toward the light source. The light source used by UCSD in this instance was a laser at APO.

The expected travel time for the light would therefore be calculated using the distance from the transmitter to the reflector and back again to the detector located next to the emitter. This is very similar to the way light is typically measured in laboratories on Earth as shown in Figure 1, with two **major** differences: (1) The distance between the emission point and the mirror is much greater, and (2) the Earth is spinning on its axis, and the emitter and detector were therefore moving toward the reflector (as in Michelson-Gale). (The moon is also moving, but its movement is negligible compared to the rotation speed of the Earth.)

The motion of the Earth did not affect the actual speed of light, in accordance with "Einstein's Emitter Only Theory," but it did affect the distance the light had to travel to complete the experiment. As a result, the NASA scientist calculated the incoming light as traveling at the speed of light plus the speed of the observatory, which he saw as "a first-order violation of local Lorentz invariance," i.e., an "impossibility."

What happened in the Lunar Laser Ranging experiments is that APO emitted evenly spaced multiple pulses toward the reflector on the moon. APO was a moving emitter (moving at roughly 500 mph) as the Earth spun on its axis. In accordance with "Einstein's Emitter Only Theory," the photon pulses traveled at c on their way to the moon. The reflector on the moon then emitted new photons back toward the Earth, again at c. At that point, APO on Earth became a **moving observer**, approaching the oncoming light pulses at roughly 500 mph, and thereby reducing the time between pulses. The receiver at APO measured the photon pulses arriving at $c + v$, where v is the 500 mph speed of the observatory. The NASA scientist using the data for his calculations saw the equipment had measured light traveling at $c + v$, and he evidently couldn't accept what his calculations showed. So, he wrote a paper about it.

Interestingly, the same data was evidently full available to a lot of other scientists and university professors who either didn't make the calculations or who did the calculations but didn't write scientific papers about what the calculations showed.

X. OTHER "EXPERIMENTS" AND EVIDENCE

Traffic control police cars have been using "radar guns" to catch violators of speed laws since 1949.[19] The word "radar" was originally a U.S. Navy abbreviation for "RAdio Detection And Ranging."

The principles and steps are very straight forward. Radar emits radio waves, which are light waves but of a longer wavelength (and a lower frequency) than visible light. As with light, the radio waves travel at c and the waves can be emitted at a specific frequency that is best suited for the work they are to perform. Because the oncoming vehicle is moving toward the police car, the radio waves are received by the atoms in the moving observer at $c + v$, a faster rate (higher frequency) than at which they were transmitted. The atoms emit the waves back at c, but ***at the higher frequency***. The radar gun's receiver measures the frequency of the new incoming waves versus the frequency of the radio waves it emitted and calculates the speed of the oncoming vehicle.

In 1887, an astronomical experiment predicted how radar guns would work. Hermann Vogel and Julius Scheiner discovered the "annual Doppler effect," the yearly change in the Doppler shift of stars located near the ecliptic due to the orbital velocity of the Earth.[20] When the Earth is moving toward a star near the ecliptic, light from that star arrives at $c + v$ and is shifted toward the blue end of the visible light spectrum because more wave peaks reach the observer in a unit of time. When the Earth is moving away from the star the light from the star arrives at $c – v$ and is "red-shifted" because fewer wave peaks reach the observer in a unit of time.

During the past couple decades, police departments around the world have been gradually implementing the use of laser speed guns to catch violators of local speed laws – replacing the older radar guns. The technique is referred to as "lidar" (LIght Detection And Ranging) and directly relates to the Lunar Laser Ranging Experiments. The lidar gun emits a single pulse at c toward the oncoming vehicle, and then receives the pulse back at c. Within the gun, the back and forth travel time is divided by 2 by a microchip to get the one-way travel time. The one-way travel time is then divided into the speed of light to determine the distance between the car and the lidar gun at the time the car was hit by the first light pulse. A second pulse is then emitted and a second set of calculations is made to determine the distance between the car and the lidar gun at the time the second pulse arrived. The change in distance that occurred between the times the two pulses arrived at the speeding car is the speed of the car. By taking several hundred samples over the course of a third of a second or so, the microchip in the lidar gun can calculate the speed of the oncoming car with very high accuracy.

The standard lidar gun technique used by police officers requires that the lidar gun (the observer) be stationary and that the target be moving. In a situation where the lidar gun is moving and the target is stationary, the pulses would still arrive at $c + v$ or $c - v$, but v would be the speed of the lidar gun "observer." And that, of course, is what happened with the Lunar Laser Ranging Experiments. The observer was moving.

XI. CONCLUSION

In Einstein's 1916 book *Relativity: The Special and General Theory*, he cites the annual Doppler shift as an example where light arrives at $c + v$ when the Earth is moving toward the emitting star and at $c - v$ when the Earth is moving away from the emitting star:

"As being of particular importance, I mention here the fact that the theory of relativity enables us to predict the effects produced on the light reaching us from the fixed stars. These results are obtained in an exceedingly simple manner, and the effects indicated, which are due to the relative motion of the earth with reference to those fixed stars are found to be in accord with experience. We refer to the yearly movement of the apparent position of the fixed stars resulting from the motion of the earth round the sun (aberration), and to the influence of the radial components of the relative motions of the fixed stars with respect to the earth on the colour of the light reaching us from them. The latter effect manifests itself in a slight displacement of the spectral lines of the light transmitted to us from a fixed star, as compared with the position of the same spectral lines when they are produced by a terrestrial source of light (Doppler principle)." [21]

Nevertheless, a little research will find dozens of college professors repeating the "Mathematicians' All Observers Theory" in on-line "study guides" and "lecture notes." And, it is very often accepted as an unquestionable fact, even though it means that if you have ten observers traveling at different velocities toward a light emitting body, they will all inexplicably measure the light as arriving at 299,792,458 meters per second.

A book published in 2011 and written by Professor Walter Lewin, who taught physics at the Massachusetts Institute of Technology (MIT) for 43 years, contains this passage:

"Einstein argued in his theory of special relativity that space and time constituted one four-dimensional reality, spacetime. He postulated that the speed of light was constant (300,000 kilometers per second). Even if a person were approaching you on a superfast train going at 50 percent of the speed of light (150,000 kilometers per second), shining a headlight in your face, you and he would come up with the same figure for the speed of light. This is very nonintuitive, as you would think that since the train is approaching you, you who are observing the light aimed at you would have to add 300,000 and 150,000, which would lead to 450,000 kilometers per second. But that is not the case — **according to Einstein, 300,000 plus 150,000 is still 300,000!**"[22]

Many other professors and physicists who interpret the Second Postulate as working that way will also argue that such a finding may seem "illogical," but that is the nature of Relativity, it is "non-intuitive." Mostly they seem to argue that it is what Einstein wrote (which it isn't), and therefore it must be accepted – even if you think it is wrong.

It **is** wrong, it **isn't** what Einstein wrote, it has been **disproved** by countless experiments, so it **shouldn't** have to be accepted, and it definitely **isn't** what should be taught in schools.

IX. REFERENCES

[1] Albert Einstein, Quoted in *Albert Einstein, Philosopher-Scientist*, Open Court; 3rd edition (December 30, 1998)

[2] Albert Einstein, *Geometry and Experience,* an address to the Prussian Academy of Sciences in January 1921, published by Methuen & Co. Ltd, London (1922).

[3] Albert Einstein, Anna Beck (translator), *English Translation of The Collected Papers of Albert Einstein, Vol. 5: The Swiss Years: Correspondence, 1902–1914*, Princeton University Press (1995).

[4] Albert Einstein, *On the Electrodynamics of Moving Bodies*, Annalen der Physik 17 (1905) Translation by G. B. Jeffery and W. Perrett, *The Principle of Relativity*, London: Methuen and Company, Ltd. (1923)

[5] Richard Chace Tolman, *The Second Postulate of Relativity*, Physics Review, Series I, XXXI (1) (1910)

[6] Raymond A. Serway, Chris Vuille, *College Physics* – Ninth Edition, page 888, Brooks/Cole (2012)

[7] Michael A. Seeds, Dana Backman, *Foundations of Astronomy, Enhanced*, Brooks Cole; 11th edition, page 91 (2011)

[8] Boden, M,: *Primer of Relativity: A Student's Introduction*, Tafford Publishing; Student Edition (November 8, 2006

[9] David C. Cassidy, Gerald Holton, F. James Rutherford, *Understanding Physics,* Springer, Chapter 9 (2002)

[10] Peter J. Nolan, "*Fundamentals of Modern Physics*," Physics Curriculum & Instruction, Inc., First edition, page 1-22 (2014)

[11] Albert A. Michelson, Edward W. Morley, *On the Relative Motion of the Earth and the Luminiferous Ether,* American Journal of Science 34 (1887)

[12] Richard Feynman, *The Character of Physical Law*, Modern Library Edition, page 150 (1994)

[13] Bernard Schultz, *Gravity from the Ground Up*, Cambridge University Press, page 196 (2003)

[14] T. Alväger, F. J. M. Farley, J. Kjellman, L. Wallin, *Test of the second postulate of special relativity in the GeV region,* Physics Letters (October 1, 1964)

[15] E. B. Aleksandrov, P. A. Aleksandrov, V. S. Zapasskii, V. N. Korchuganov, and A. I. Stirin, *Measuring Speed of the Light Emitted by an Ultrarelativistic Source,* JETP Letters (2011)

[16] E. J. Post, *Sagnac Effect*, Review of Modern Physics, Vol. 39, No. 2 (April 1967)

[17] Albert A. Michelson, Henry G. Gale, *The Effect of the Earth's Rotation on the Velocity of Light – Part II*, Astrophysical Journal 61, 140 (1925)

[18] Daniel Y. Gezari, *Lunar Laser Ranging Test of the Invariance of c*, arxiv.org (2010) https://arxiv.org/abs/0912.3934

[19] Associated Press, *Speeders in Connecticut To Face Real Radar Test*, The New York Times (February 8, 1949)

[20] A. Pannekoek, *A History of Astronomy*, Dover, p. 451. ISBN 0-486-65994-1. (1961)

[21] Albert Einstein, *Relativity: The Special and General Theory*, Ancient Wisdom Publications, Chapter 16, p. 82. (December 17, 2010)

[22] Walter Hendrik Gustav Lewin, *For the Love of Physics*, Free Press, p. 269. (2011)